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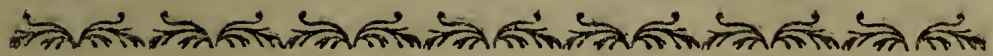
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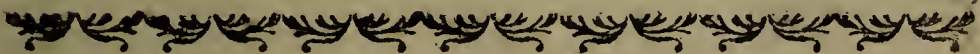
WILSON, A

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Medical Researches.



MEDICAL RESEARCHES:

B E I N G

An ENQUIRY into the NATURE and ORIGIN of HYSTERICS in the FEMALE CONSTITUTION, and into the Distinction between that Disease and HYPOCHONDRIAC or Nervous Disorders,

C O M P R E H E N D I N G

A Specification of the characteristic Refinement and Excellence of the FEMALE CONSTITUTION and CHARACTER. A Research into the Materiality of these Occult Powers and Principles of Activity, commonly called LIFE, in the Human Frame.—Into the real Existence of an Image of our whole Organical Frame, in the Seat and Fountain of its Powers, and the physical Probability of there being a Regeneration of that Image in Organs formed for the

Transfusion and Multiplication of Individual Life.—The true Nature, Symptoms, and Indications of Cure of the HYSTERICAL Disease.—The Abuse of Sugar, as a Cause of its increased Frequency, and the increased frequency of Infant Mortality.—The precise Seat of Animal Heat.—The Structure of the Blood.—Practical Hints, relative both to the Hysterical and Hypochondriacal Diseases, and the Management of them, &c. &c.

T O G E T H E R W I T H

The SUBSTANCE of a DISCOURSE, proving that the Motions of the Blood and Animal Fluids, do not depend on the Impulses of the Heart upon the Blood, but must be referred to other Causes, and particularly to an Animal Modification of that universal Principle which is the common Cause of all Organisation, and of all organical Motions in Bodies.

T O W H I C H A R E A D D E D,

FOUR LETTERS to SIR HILDEBRAND JACOB, on the MATERIALITY—DENSITY—and ACTIVITY of LIGHT; and on AIR.

BY ANDREW WILSON, M. D.
Fellow of the Royal College of Physicians at Edinburgh,
and Physician to the Medical Asylum, London.

L O N D O N:

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M D C C L X X V I,

310855



THE AUTHOR
TO
THE TRULY LEARNED
AND
MOST RESPECTABLE BODIES
THE UNIVERSITIES OF
OXFORD and CAMBRIDGE.

I SHOULD account myself guilty of a very great violation of the high respect I both owe and pay to the two most distinguished seats of learning and nurseries of science in the world, to invoke their attention or regard to any small medical tract of a private nature only.—I confess the title of this little piece does not bespeak it such as to claim either the acceptance

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or patronage of two such venerable seminaries of universal science, whose honourable province it is to plan out, and rear the whole fabric of learning, upon the most solid foundation, and of the most substantial materials.—May the edifice ever flourish and never decay among your hands!——But you will readily discern that the title of these discourses is in a great measure used as an occasion to throw what Light I can into the obscurities of a subject, which tho' connected with my professed design, is in reality of a much more comprehensive nature, referring not only to the principles of medicine, but to those of philosophy itself: And tho' my introducing these views, may appear in this work as seeming aberrations from its title, You will also discover in the work itself some apology both for my retaining the title affixed to it, and for connecting with it matters I could not

not

contained in the following sheets, as an
appeal to your candour and discern-
ment.

LONDON: }
Adelphi, }
May 8, 1776. }

E R R A T A.

Page 80. line 7. for complexion read completion.

Page 135. line 18. for natural read neutral.

Page 153. line 15. for contact read concussion.

Page 182. line 10. for as read whereas.

Page 183. line 5. for happens read happen.

Page 192. line 3, note, for relapse read elapse.

Page 194. line 20. for return read returns.

Page 202. line 8. for prision read origin.

Page 155. line 8. for in read into.

Page 269. line 7. for them read both.

N. B. The Discourse on Fevers, mentioned page 162, as a part of this work, is prevented from being inserted by an unforeseen accident.

AN ENQUIRY, &c.

IT happens too frequently, that, from some general, imperfect, but by no means exquisite, analogy among Symptoms, very different diseases are either mistaken for one another, or are confounded indiscriminately together. There is not, I believe, one other such general cause of mistakes in the whole compass of the practice of medicine, as this. Nor can this cause of errors be redressed, until some medium is discovered and established for reducing men's assumption of physical principles, and their method of reasoning upon facts to a greater precision and uniformity.

THERE certainly is, in every Science, some leading Truths, which, like the trunk and greater branches of a tree, or like the great vessels of the animal œconomy, communicating with every twigg and filament of each, renders the parts of the whole traceable, either backward or forward, and demonstrably unites them together. He would be a happy Genius, and merit much of the Public, who could discover and well demonstrate these leading principles, and truths which pervade the whole, and unerringly guide the understanding, in a Science of such importance as medicine is, when the knowledge of it comes to be reduced to practice and application.

It is from an error of the above-mentioned kind, from some similarity of symptoms, common to Hyfteric and Hypochondriac diseases, that these two have generally been accounted analogous diseases, distinguished in their
names

names only, to distinguish the sex that is the subject of the disease. But this I take to be a total mistake; which I propose to correct at present, principally by endeavouring to ascertain the nature of the Hysterical disease, and by shewing that it is a disorder peculiar to the female constitution, originating in it from causes that have no existence in the habits of males. With the same propriety, may some species of Epilepsies, and some symptoms occasionally produced by Worms, be ranked with Hypochondriac and Hysterical diseases, as these two disorders can be confounded with one another.

IN order therefore to form as clear and adequate conceptions as possible of the Hysterical disorder as distinguished from all others, I apprehend it is requisite first to ascertain what is common to the constitution of both sexes, as distinguished from what is peculiar to the nature and constitution of females.

C H A P. I.

*The Identity of the General Nature of the
Sexes.*

TH E R E is nothing, so far as respects diseases or morbid affections, peculiar to males, or to which females are not exposed in common with them. As individuals of one species, they have a common constitution reared and supported upon the same general animal principles and laws, and subject to the same infirmities and affections which are accessory to the generating of diseases. It is true that the different degrees of that common constitution dispensed to each sex, and indeed to each individual, renders one more exposed than another to this or the other disease, yet from the danger of which neither is totally exempted.

IT is also true, that each Sex has its own characteristic organs and parts which the other has not, and that these may be the seat of diseases ; but of such only as both are incident to. All the parts of each Sex, however distinguished in form or office, are composed of the same animal materials, solids and fluids, blood-vessels and nerves, membranes, and glands, &c. which are incident to the same casualties and diseases, whether general or particular, topical or universal. In so much then are females of the same constitution with men, that I do not recollect that disease males are liable to, that women are absolutely exempted from.

NAY more ; that system of reciprocal desire and attraction, that principle of coalescence, which, by the irresistible decision of the excellent Former of our natures, bends the sexes towards each other, and is ordained to unite them inseparably in person, affection, and
C 3 interest;

interest; That, I say, can afford no foundation for the characteristic distinction of the sexes I enquire after. For a sympathy which is as undistinguishable in its feeling by the different sexes, as joy or grief is, and which has nothing in it, and tends to nothing, but what is mutual, cannot, by any disorder of it, be productive of dissimilar diseases or effects in constitutions formed in every respect alike, both as to materials and animal composition.

C H A P.

C H A P. II.

*The Sexual Degree of Bodily Constitution
belonging to Females.*

THOUGH the animal nature and constitution of females in every respect symbolizes with that of males, yet we ourselves being judges, must admit that there is a great odds in favour of females, in respect of delicacy of frame.

NATURALISTS in all ages have allowed this. The old physicians expressed this very imperfectly, by the terms *colder* and *hotter*; nor have the moderns come more up to the point, by the distinction of *weaker* and *stronger*. If the distinction could be comprehended under two Epithets, I apprehend the terms *finer* and *coarser* would come much nearer the point; as the same materials

and pattern may be manufactured upon a coarser or finer plan.

IN females, the proportion of their fluids to the solids in their composition is greater; the fluids themselves are less dense and tenacious, and more susceptible of rarefaction than in males. Their solids, both in their ultimate fibres, and in their contexture into larger vessels, are of a finer extension; and both their solids and fluids are more yielding and susceptible of the influence and energy of that ethereal fluid, which is the immediate principle of mechanical, natural, or animal life: Hence the organs of their senses are endowed with more susceptibleness; their muscles and ligaments are more flexible and active, tho' sooner exhausted, and their skin is purer, more delicate and extensile than that of men.

ON these accounts, the senses of females are quicker and more lively; and
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though they cannot vie with men in strength and robustness of constitution either of body or mind, yet, by the flexibility of their frame, they are formed for bearing shocks and sustaining alterations, and even pains in their constitutions, which that of males would sink under the impressions of.

IN short, they are not colder or weaker, by any defect of the powers of nature rendering them less susceptible of a perfect animation, but by a finer and more subtile intention of its energy. The flexibility and softness of their frame is a designed work of art; and proceeds not from a defect of nature, leaving them incapable of being so perfectly animated by the powers of life as males are.

As I have once and again made mention of the vital, as a material mechanical principle, I think it requisite, in order to be more clearly understood in
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the succeeding parts of these discourses, that I should here explain myself upon that subject; premising this, that I would by no means be understood to include, Consciousness, and those higher powers of the rational soul, which elevate our capacities for the reception of intellectual life and immortality, in my ideas of the principle of animal life.

C H A P.

C H A P. III.

The Sidereal Part of the Constitution of all Terrene Bodies, and of the human Frame in particular.

IF I cannot deliver my sentiments on this subject with sufficient conviction, I will at least endeavour to do it as explicitly, and with as much precision, as I can.

So many occult qualities, inscrutable principles, and indeterminate powers have been, and are, by Ancients and Moderns, introduced into a co-operation with the materials and mechanism of the animal frame, that it is become impossible to define or conceive, what we are supposed to be a composition of, or wherein animal life consists.

THE

THE whole, in my opinion, is the result of, and ought to be referred to, material mechanism; and my reason for this conclusion is,

IF all these, commonly supposed occult qualities of activity and unintelligible symptoms of power and energy resident in, or annexed to, different material substances did not depend on mechanism and that only, then it would be impossible that such virtues could be either generated or destroyed.

PHILOSOPHY does not suppose that mechanism can affect such properties of bodies, as belong to them independent of it. Mechanism, or a new distribution and arrangement of materials, could not in that case generate elasticity out of non-elastics or plastics, electrics out of non-electrics, or concoct life, and the various seemingly unrelated symptoms of vitality in the animal composition, out of materials that are
 endowed

endowed with none of these principles. But the fact is, that Nature * seems to have an unlimited power of inverting and changing, and generating all the specific qualities of bodies according to the modulation of the material organs that it occupies.

MATERIALLY, the living animal frame consists of two parts.—ORGANICALLY, it is distinguishable into three parts.

THAT ingenious old physician and philosopher, Tachenius, reduced all the natural principles of things into acids and alkalis; the one the soul, the other the body of every natural substance.

CHANGE the terms, and the truth of his doctrine will become both more evident and more intelligible.

* By *Nature*, I would always be understood to mean, these subtile principles of the mechanism of the world, and of all material things which are insensible as causes, and discover themselves sensibly, only by their effects.

EVERY material being, through all the forms of nature that have been, are, or can be known, is a composition of CELESTIAL and of TERRESTRIAL matter. This distribution of matter into these two classes, which is the real key of all natural knowledge, not only distinguishes this globe from the celestial fluid in which it swims, but it is to be applied to every individual terrestrial substance; which must be considered as an intimate composition of these two elements; the latter being the organ or case of the energy of the former, and the modifier of its incessant activity; while the former impresses these characters on the latter, which are known by the name of the distinguishing properties of different bodies.

FOR almost these forty years past, the curious have been teasing this celestial matter with the varied experiments and tricks of electricity, with so little success, as not to have yet ascertained, that

that it is the one omnipresent animating principle of all natural things, upon which every property and phœnomenon of material being, under all the metamorphoses and transfigurations that natural bodies undergo, depends; and without which, all that we call Body, would remain for ever an inactive, passive, incoherent calx.

THIS celestial matter is no other than the fluid of LIGHT; which, according to the variety of the phœnomena by which its energy has been discovered to us, has been called under different circumstances, Light, Fire, Ether, Electrical Aura, Materia Subtilis, Materia Media, &c. and which at other times, has been stripped of its materiality all together, and treated as a principle annexed to, or inherent in matter, under the terms of, Occult Quality, Nifus, Attraction, Gravitation, Elective Attraction, Elasticity, Irritability, Sympathy, Vital Principle, Life, &c. &c.

I SAID,

I SAID, that ORGANICALLY CONSIDERED, the animal living frame was distinguishable into three parts; namely, Solids, Fluids, and an Etherial Form which animates every particle of each of these in our composition.

THIS celestial part of our constitution exists in us, and indeed in every other form in nature, in two modes; namely——interstitially and organically.

IF the pores of gold itself, the densest of all known earthly substances, exceed its solid or earthly parts, how much greater must the proportion of solar fluid in our composition be, than in that of gold?——Let me illustrate my meaning by an example of the most simple of all known bodies, namely, the element of water; which when perfectly pure, consists, so far as human analysis or penetration can discover, of perfectly similar parts.

IN the form of water, those similar parts which constitute the fluid must have interstices between them, even admitting them to be all in contact with one another. Water, by its transparency certifies our sense, that light has free access into and through its substance, and therefore must fill up these interstices, just as water does a sponge soaked in it.

BUT we know, by the volatilisation of water, that light or fire, has not only access to its interstices, but penetrates and occupies its similar elementary particles also; in the conformation of which particles, the character of water consists. These particles could not be rendered volatile but by internal dilatation, nor could they be dilated but by something that reached their internal parts.

THESE particles then are the organic parts of water, which have their individuality as separable elementary
D parts,

parts, as well as their similarity of character, preserved by that etherial principle possessing them.

THESE points being cleared, they yield a clear and obvious solution of all these obscurities with which present physiologists puzzle themselves, and seem disposed to resolve into some incomprehensible mystery; such as, What is the principle of life? Wherein does it consist? Where,—in the solids or in the fluids,—does it reside? Is it not plain, that both must be necessarily the immediate organs and receptacles of it; and that each must be equally accessory in every point of our frame, to the support of its vivacity in the other *?

THE

* Modern physiology has bewildered the ideas and conceptions of pupils in the science of medicine, by not distinguishing between the term *Life*, used *metaphysically* for our system of consciousness, or as a result of our whole composition, explicable only by the Creator; and

THE vital state of this ether in our fluids, lies not abstractly in the degree of heat it exhibits in animals: For heat ascertains the quantity only, but not the modification of the motion of that fluid in animals. It lies not in any permanent properties in the component parts of our fluids; but it lies in that species and modification of its motion, by which the actual constant progressive mutations of the fluids are carried on, of which the maintenance of the animal heat is a necessary consequence.

WHENEVER the fluids have passed through that series of mutations or digestions, which the vital ether accomplishes according to the modifications

and the same term used *physically*, to denote the natural power that presides in our frame, reciprocally regulating, and regulated by the mechanism and disposition of the whole, and of every part and particle of our corporeal frame.

of the diverse parts in and according to which it acts, then they are either fixed as solids, where any parts will admit of them, or they are expelled as recrementitious subjects become effete, and whose vital modifications are exhausted.

By the medium and instrumentality of the solids, indeed, the vital principle celebrates these functions, acts in these directions, and with that stability which could not be attained by fluids alone, though their incessant co-operation in their vascular state is essentially necessary to these functions of vitality that immediately depend on these solids.

In short, by the unremittent, reciprocal corruscations of this vital principle in the fluids and solids upon one another, according to the different qualities and consistencies they assume in the different parts of our constitution, is the whole

whole system of life displayed and maintained in every individual.

ONE strange opinion I must take particular notice of, that has somehow or other been admitted of late, and passed current among many physiologists; that, namely, the solids are ultimately an accretion of earthy particles, sucked together, somehow or other out of the blood, by, I suppose, their elective attraction, or some such imaginary inherent power of association.

NATURE in my opinion, employs no such bodies formally in her operations, as what naturalists and chymists mean by terrestrial particles. Casually, there may at times be found such inorganic particles as are called terrestrial, floating in water or other fluids; but earthy particles in that form, Nature never uses or blends in her compositions either fluid or solid.

WATER, salts, and oils, are the formal elements she uses in all her operations.

THE last of these is Nature's final concoction; and out of these oils properly concocted, condensed and incorporated with a certain proportion of the other elements, are all the ultimate solids both of animals and vegetables composed. Perhaps, I might venture to include minerals also. I doubt if Nature exhibits any solid, without employing what Chymists have called Sulphur, as the principal basis of them.

I KNOW nothing of any kind of fixed air essential to their composition; except some elastic acidity or acidulous effluvia that may be drove out of solids; which, while it entered the composition, and formed a constituent part of the solid, was cloathed with a sulphureous form*.

* This matter I have explained my opinion more fully upon, in a note towards the end of my discourse, on the Causes of the Circulation of the Blood.

THE earth that remains so plentifully after the calcination of solids, is no more than the ruins of the neutro-saline and oily particles, which before the oil took form, was the neutralizing part of the salt, out of which it was concocted and inverted into an oil; that part in the oil which was the acid exploding into actual flame, or constituting the ignition of the coal, while as much of the neutralizing part of it as is not elevated in the form of volatile alkali, remains in the form of an inert inorganic earth. Inorganic, I call it, in a limited sense; because it is no form employed in the processes of Nature; but no terrestrial substance that the matter of fire or light has access to, can remain absolutely in an inorganic state;

C H A P. IV.

*Of the Refinement of the animal Principles of
the Female Constitution.*

HE must be very partial indeed, and blind to the decision of Nature, who is not conscious of the same superior elegance and delicacy in the temper and spirit of females, as there is in the structure of their person and form. There have been at times, women who have shewed themselves not incapable of all these acquisitions of learning, and of that superiority of understanding, which all men boast of in a few of their sex. Nay, if there is much respectableness of capacity in that, there have been women too, who have played the crafty ambitious politician, or the heroic tyrant as much to the life as ever any man did. But there are pre-eminences in their natural dispositions, more excellent than these that are displayed so conspicuously
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in the popular walks of patriotisin or faction, or even in the more envied and more mystic labyrinths of state.

THE female nature is moulded for a more important superiority and a nobler department in the republic of human nature; for an absolute jurisdiction over the regions of infancy and the dawnings of life; where human nature is proud of its dependance, and obedience is the most exquisite happiness. This is the golden age of life, when females sway the despotic sceptre of unlimited tenderness and affection; where the loftiest monarchs never can enjoy that happiness in commanding, that they have felt in obedience and dependance, and which the best of them would, if they could, renounce all the pageantry of greatness and royalty to retaste the innocent careless joys of.

IN truth, the minds of females, as well as their persons, are formed for the
most

most important offices of humanity;—the charge of infancy, and the sustaining with patience, that trouble in their own persons, which is annexed to their bringing infants into life. Therefore all their feelings are softer and finer; all their passions are more delicate and more exquisitely tempered with sentiment; their imagination is more lively and fertile, and their apprehension is quicker. At the same time, their temper is more mild and acquiescent; their moral sentiments are more genuine and pure; being less corrupted and tarnished with the distinctions and sophisms of reasoning, their desires and pursuits are more limited and less exorbitant; their engagements, and therefore their enjoyments, being more domestic and beneficent, are consequently more virtuous and moral in their nature.

It has been considered by some who would be thought philosophers, as a proof of female weakness, that they are
more

more susceptible of religious impressions than men. But when we consider that the evidence, the stability, and importance of religion, is based on the certainty of the evils it is proposed to redress; and that nothing but the invincible truths thereof, and its spiritual prospects, could ever have been found an adequate and rational balm for the certainty of death, the uncertainty of life; the miseries, the vanity, the folly, and the vices of human nature; when we consider these things, I say, we must conclude the philosophy of such reasoners weaker than the credulity of the sex they affect to impeach; for what is in fact a valuable excellence, founded on the constitution of their mind, and the department assigned them, on the stage of temporary existence. If in all religious assemblies, as I have heard it often observed as a reflection on the sex, the women out-number the men, I would have such candid censors to remember, that the deficiency of males on such occasions, is not to be attributed

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ed to the superior cautiousness of their understanding against seduction, but to the greater indifference of their minds to the subject.

IN fine, as women are assigned on the theatre of life, a series of labour, suffering, and tender duties, in the cherishing and rearing of infant-being, which the refractory, unsusceptible composition of males disqualifies them for; therefore, they are distinguished with a refinement in the execution of their whole frame, both of Body and of Mind, which would render them the objects of our envy, if the whole was not wrought up into a captivating elegance, not to excite transitory delight, but to engage us into union with them for life, and animate us with every tender sentiment and attention that can contribute to their happiness, or alleviate the sufferings and afflictions they are necessarily exposed to, in fulfilling the ordinances of their sex.

C H A P.

C H A P. V.

*The Casualties and Incidents to which the
Female Constitution is exposed.*

T H E R E are many peculiarities in the constitution and circumstances of females, that operate as causes, unknown to males, of almost all these diseases that both sexes are subject to in common; therefore it is no wonder if that sex is accounted tender and more subject to diseases than men; but this is not through the infirmity of their constitution, but by reason of the various vicissitudes and revolutions in it.

BOTH sexes are subject to a change of constitution, in passing from puerility, or a state of nonage, (during which period, their constitutions may be accounted the same,) into puberty; or that age in which the plan of nature in
distinguishing

distinguishing the Sexes, begins to unfold and explain itself.

THE constitution of males rarely suffers any danger, and not unfrequently is improved or mended, particularly of some diseases, by that change. The reason is, because, at that period, Nature has no new, involuntary sources of secretion, or strainers of fluids to open in them.

IN females, on the contrary, Nature at that time has an involuntary derivation from their fluids, which it was unaccustomed to before, to open and to establish for the future. If there is any disease, topical weakness, or flaw in the constitution, when Nature comes to address itself to the accomplishing of this great change; these not only act as impediments to the design of nature, and are the causes of disturbing the whole constitution, and of bringing on a bad habit, or encreasing the disorders
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of it; but if the different parts of the constitution are not all equally firm and qualified to resist the encreased momentum of the blood at that time, the direction of Nature becomes inverted, and the lungs, for example, or any other weak part becomes the receptacle of that fluid, which was intended to be separated from the blood, by a natural channel.

THOUGH the periodical derivation peculiar to the female sex, is neither accomplished nor determined in its periods, by a mere plethora, or overfulness of the blood-vessels; yet whenever that discharge is suppressed, it is sure to induce a plethora. In other words, the constitution in its natural state of health, opens these periodical fountains of public life, as they may not improperly be termed, not because it is over-full of blood, but by a secret vital irritation on these organs, disposing them to remit their ordinary retentive power, in order to keep them
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in exercise, and prepared always for ministering elementary living substance to new principles of being. In any disappointment therefore that Nature meets with in the performing of this derivation, it is the resistance to the tendency or rîfus of the fluids, and not an universal overfulness of them through the whole constitution, that is the cause of the plethora, and disorder felt in the habit.

THERE are fundry causes that render this periodical subtraction from the female blood very critical and apt to be disturbed, to the great hurt and danger of their constitution.

ALL other natural derivations are open from the beginning of life; Nature, from the moment of birth, is habituated to them; therefore its courses are well established. Not only so, but in all other secretions, Nature is uninterruptedly, and without cessation employed;

employed: Perspiration, the secretions of all the glands, &c. go on without intermission. But this characteristic derivation of the female sex, is periodical and stationary, and suspended by cessations, far more prolonged than the duration of its flux is.

AGAIN, this flux has its period of final termination as well as of first commencement; the one as much subject to accidents affecting the health and constitution as the other. Add to all this, that the fluid thrown off in this operation peculiar to the female nature, is not an altered fluid, a changed liquor concocted and drained off by any glands. It is pure, perhaps the purest, most vital and animated blood; which Nature in no other case has regularly destined for secretion or being parted with, otherwise than by transmutation into other more permeable fluids.

ALL these circumstances are like so many critical points, upon which the health and well-being of the feminine nature momentarily depends.

How various again are the accidents to which the health and constitutions of females are exposed during pregnancy, and of how many different kinds, according to the different stages of it! It exceeds the intention of this undertaking, to class or enumerate them.

BUT supposing, what happens for a wonder only in a few very happy constitutions, that a woman escapes all these, yet certain trouble and anguish, besides many uncertain difficulties and dangers, attend her period of delivery. Though both mother and infant escape alive, yet Nature has ordained that the breaking up of such an intimate union, the rending of life from life, shall not be effected without exquisite suffering and pain; while danger hovers over
every

every hour of the mother's recovery from these shocks, till Nature has repaired them, and re-established the constitution again, in the habits of the Sex. In short, the only duty peculiar to the sex, in which Duty, and Pleasure, and Benefit to the Constitution, are almost perpetually united, is Nursing. There is no pleasure so pure or more exquisite, nor any duty so salutary and wholesome as that is in general; though not universally.

C H A P. VI.

The Characteristic of the Female Nature and Constitution.

HIGHLY useful as anatomy is, in acquainting us with the Organs, their Structure, their relative parts, Relations and Connections, Intercommunications, &c. in and by which the different functions of our system are discharged; yet it goes but a very short way in unfolding to us the diversified specific powers of each Organ. What that specific power and structure in them is, which enables one gland to concoct and secrete one kind of humour, and another gland, another kind, lies out of the reach of the knife, of injections, or the optical glass to detect. Therefore the ultimate object of all these labours in physiology, tends only to assure the understanding of this conclusion, that
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mechanism is absolutely necessary to Nature, in all her most refined and ultimate operations.

BUT as Nature does nothing without mechanism, she has also a wonderful power (indeed the most wonderful part of all her processes) of generating her own future organs, in bringing forth new individuals.

IN this only is the power of Nature limited: She cannot act determinately in generating new beings, excepting in a system similar to the beings she generates. In such, she has an inexhaustible power of generation; but without organs first compiled for her to act in, she never could have produced one determinate being. The first production of mechanism throughout the whole compass of Nature is, therefore, as much a work of the Creator, as the birth of matter itself.

○ AFTER all that is known of animalculæ, and ova, and of embryo's found in the Fallopian tubes, &c. the act of generation, and what individually each sex contributes to it, remains still a mystery. Whether one sex furnishes the rudimental organ of an individual, and the other excites the first determinate action of that ethereal principle that is to animate and possess it, I will not determine. However, I must say, that I think the learned and sagacious Dr. Harvey's theory on that subject, has still more verisimilitude in it, than the doctrine of the animalculæ, and their nidi or ova; which to me carries this absurdity in it, that ultimately it makes generation the work of the male alone; and which is still more absurd, it reduces the generation of living animals to the mere secretion of a gland or glands. Why should Paracelsus's receipt in his Archidoxis, for hatching homunculi, be reckoned incredible by people who can believe this?

WHAT

WHAT generation is, I say, I know not; but there are two things relating to it, that I have no doubt of. The first is, that the wills of the sexes have as immediate a concern in it, and operate as immediately by their concurrence, as either their organs or their fluids do. The other is, that it is a simple act, which is perhaps as momentary as a stroke of electricity itself.

BUT however these things are, my subject has no further concern with them; because I cannot rest the criterion of the female character on a transient act, in which it is impossible to distinguish between two efficient, where the effect is one and common, however distinguishable the mode of their concurrence may be considered.

UPON this impression of themselves struck by the sexes, it is, that the characteristic powers of the female sex begin to operate and display themselves.

GENERATION is an act of the sexes; but CONCEPTION is the proper, sole work of the female nature; and as conservation ought, with the strictest propriety, to be considered as a continued act of creation, so is pregnancy in reality, a continued act of conception. It is for the sake of this important work, that the Author of our being has adorned the sex with all that comparative delicacy and elegance of body and mind, which I have already hinted at.

INFIDELITY and credulity are often as intimate associates in philosophical as in religious researches. Many physiologists, who make no doubt of the doctrine of *Animalculæ*, already hinted at, are absolute infidels as to the possibility of infants receiving marks in the womb, from the imagination of the mother; but such examples are too frequent and too well attested, to receive discredit from an occasional philosophic scepticism, and to be reduced to the
 article

article of mere contingency. I myself have seen instances of children born not only with marks, but with open running sores, similar, both in their seat, extent, and appearance, to accidental injuries the mother received during her pregnancy*.

THERE is as certain a correspondence between the mind or imagination of the mother, and the form of the infant in the womb, as there is between an object, and its image in a mirror. The medium of this communication with

* A pregnant gentlewoman standing on the leaf of a folding-table to reach at something, the leaf gave way under her, and in her fall, the edge of the table stripped her leg and thigh of the scarf-skin, from the ankle, to the middle of her thigh. The child was born with an open oozing tetter of the same extent on its leg and thigh, which sometimes had been skinned over, though it always broke out in a short time after. I was consulted about that sore, when the boy was about eight or nine years old, and in other respects a very healthy child. Various other instances of marks so impressed I could adduce from my own knowledge.

the infant, must be the same with the medium of its nourishment.

THIS reflection of the female mind, or of the form of life there, upon the feat of coalescence between the mother and the child, is, in my opinion, that very thing in which the female character consists; and is the primary cause of that coalescence itself between the mother and the embryo. The one is thereby formed and qualified for irradiating, what the other is formed for drawing and taking in. It is this which opens the sources of the mother's vital fluids, to the demands of infant nature: Just as the breasts, which were empty immediately before, are well known to fill and flow, when the mother's tenderness begins to glow on the immediate prospect of laying the infant to her bosom; that she has been for some time absent from.

THERE

THERE are some doctrines, and this is one of them, that demand illustration, rather than confirmation: In other words, illustration is the most satisfactory confirmation that can be given of them. This I shall attempt.

THERE is the same reason for saying that a child in the womb lives communicatively, as that it is nourished communicatively. Tho' present physiologists have not determined what life is; they all agree that it is a principle distinct from the known materials, and sensible mechanism, of our composition; but while we live, I suppose they will admit, it is every where a concomitant of our substance.

As the existence of this principle is known to ourselves, and to one another, by the conscious operations of our minds; we have as good reason to call the seat of these operations, the fountain of life shedding itself through every
particle

particle of our frame, as we have to call the heart, the fountain of our fluids.

THOUGH we think consciously, it does not follow, that we are conscious of all that is performed in this fountain of life, or that consciousness attends all its incessant functions. When we will the motion of our eye, or of our toe, we are unconscious of either the reality, or of the manner of the will's addressing itself to these parts. At the same time, we are as certain, as necessary consequences can make us, that the will could never reach these members, unless in the seat of its action, it found something that corresponded with them.

CAN we have any stronger rational demonstration, that there is an active, living, material image of the whole frame, in the fountain of life, with which the conscious mind corresponds at pleasure? But though we feel this principle subservient to our Consciousness

ness in actuating our frame, it does not follow, that this is all the office it has to perform. On the contrary, we must conclude, that the same principle must insensibly to ourselves perform all its vital functions by the same kind of energy.

WE have many other circumstances to satisfy us, that it lives in necessary and uninterrupted influencing correspondence with every part; insomuch, that it would appear, if any part of that image was to be obliterated in the fountain of life, or its communication with any part interrupted or broken off, that part would cease to live instantaneously, though the access of our fluids to it was ever so free.

THAT this living modulation of our whole frame, supported by the re-action of every living part, or by the reaction of life in every part, upon the fountain of life in our composition, has

has necessarily the same instantaneous and permanent reaction on every part, is, in my opinion, a necessary consequence: And that it is so in fact, we have demonstration from the momentary effects displayed through the whole system of our constitution, whenever this model of ourselves in the fountain of vitality, is agitated in any specific manner by our conscious passions of Love, Anger, Fear, Shame, Joy, *etc.*

WHEN this is evidently the case, can it be any wonder, or in any measure un-supposable, that a particular part of the human constitution may be so formed as to be susceptible of an impression or regeneration of this intire image delineated and preserved in it for transmission to new beings, when they come to be presented and annexed to it? This I have no manner of doubt is matter of fact, in regard to the organ and seat of conception in the female sex.

THIS

THIS image of the whole frame of every animal in the centre and fountain of life, which sheds its irradiations into every part it is the representative of, I cannot by similitude give a clearer and more distinct idea of, than by comparing it to the action of light in a focus, which contains as it were in a point, all that is delineated beyond it in an extended landscape.

THOUGH I look upon this as a very near similitude to the idea I would convey of what must be a matter of fact, however it is explained, yet when on this subject I use the term Image, or any other similar to it, I would not be understood optically or literally. I mean a potential image, if I may use the phrase; where there is, without the least confusion of parts, as distinct a concentration of the powers of life, as there is of forms in the focus of a perspective glass.

THOUGH

THOUGH an infant in the womb has all the members and organs, and the same connections established among them, which one that is born has, yet certain it is, that none of them act officially, until they receive a proper uterine completion. They have nothing personal in their senses, motions or secretions ; these all follow the habit of the mother, and are affected by her feelings and sensations both of body and mind. They are shocked, influenced, and affected through her. Their life, as well as their fluids and solids, are her's: the whole is common to both: the life of the infant in that state is totally derivative.

THAT wonderful elaboratory of human nature, the organ of conception in the female sex, must have a capacity in itself, by some display of Wisdom in its structure or contexture, of regenerating in itself that whole form, and all those powers of life rendezvoused there,
in

in such a manner as to be transmitted and distributed entire, and without confusion to every correspondent part and member of the vegetative infant, according to the similarities of the different crasis and construction of each.

UPON a collation therefore of all that I have said relative to this subject, I cannot think that I express myself with great impropriety, or speak quite metaphorically, when I say, that by some special and direct connection between the fountain of life and the organ of conception in females, the seat of that procreative faculty in them is susceptible of having excited or regenerated in itself, the image or powers of that whole faculty in the origin of life that corresponds with, and extends its influence and energy to, every part of the body; and that whenever a proper subject is generated there, there is during pregnancy an incessant transmission of that vital image from the seat of coalescence

to every constituent part of the infant: in some such manner, to explain myself again by similitude, as the image from the bottom of the eye passes through the optic nerve, to the seat of perception, or from that back again to the organ of vision *.

* We inattentively imagine the seat of sense is passive in receiving images, but in fact, it also positively directs a ray from itself, to every object it perceives. The action and reaction between objects, and the seat of sense, is wholly reciprocal. Hence, in some cases, we are even conscious of this; seeing objects, or their image, after the eye is turned from them; hence also, in a delirium, the objects of the imagination, receive a real representation in the organs of sense. For the same reason, we see not an object the eye happens to be fixed on, if the attention is otherwise engaged.

C H A P.

C H A P. VII.

This Characteristic of the Female Constitution the immediate Source of the Hysterical Disorder.

IT is this faculty, resident in the Organ of conception, of having renewed in it an impression of the whole system of animal life, as it exists in its fountain, and irradiates its influence into every part; it is this faculty, I say, that is the immediate source of the Hysterical disease, the nature of which, cannot be comprehended or explained upon any other principles. I observed before, that the mere diversity of the form or compages of any parts that distinguish the sexes cannot, for the reason I there assigned, be the foundation of a distinguishing disease. A characteristic disease must originate from some criterion of distinction between the sexes.

This is not to be found either in the fabric, or any property belonging to the fabric of males, as has been before observed.

BUT the hysteric disease distinguishes itself from all other diseases in this, that it is a disease of *the principle of life itself*: That is, the leading principal symptoms of it are such as act immediately upon that principle. That this disorder has always been understood to derive its cause from the female Organs of conception, is evident from the name it bears: And that it was so singular in its symptoms, as to lead physicians to attribute it to the principle of life, is evident from the manner in which many of the old physicians solved the phœnomena of it, namely, by attributing to that feat of transmission of life in females, a life of its own independant of the rest of their constitution.

THE fact is, that instrument of the being and preservation of mankind, is of such importance, that the wise and provident Author of all things, provided, that when that member was disturbed or interrupted, by the various accidents females are exposed to, in its secretions, that these suppressions should not generally, nay, I may almost say, universally, act in the manner of what we call topical obstruction, producing any inflammation, swelling, or unnatural collection, or digestion of humours in the parts.

ON the contrary, he secured that organ from such accidents, by endowing it with such a degree of reaction to any load tending to settle there, as enabled it to react upon the whole system of life, in order to vindicate itself from such consequences of obstruction, as might injure the vital powers seated there, for the preservation of the human race.

As, therefore, this Organ of such importance, subsists in such communication with the fountain of life, admitting and transmitting its whole entire impressions, is it to be wondered at, that upon any disorder, it is thrown into by obstruction of its office, it should act by reflection immediately and directly upon the principle of life in the female constitution? For such as distract it, are the leading pathognomonic symptoms of the Hysterical disease.

C H A P.

C H A P. VIII.

The Symptoms of Hysterics arising from Sympathy.

THOUGH such, as I have said, are the critical symptoms of the Hysterical disorder, yet they must not all be referred to that class. That repository of communicative life, has, by its situation, connections with other parts, and connections by blood-vessels and nerves, by which means, under its disorders and disturbances, these consensaneous parts are affected.

THEREFORE hysterical affections are to be distributed into two classes: First, such as are produced by consent or sympathy of parts; and secondly, such as are an immediate reaction upon the principle of life itself at its fountain; from whence that Organ is always impressed and irradiated upon in the

manner and for the purposes above explained.

THE provident Author of our being and determiner of the manner of our introduction into the world, has solicitously secured that elaboratory of mankind in the female constitution, from the common topical accidents that happen from obstructions or disorders of the secretions of other viscera. I do not say, that such never happen there: But only, that this important vessel, by the powers belonging to its fabric and animation, is enabled in thousands of instances to clear itself of the consequences of obstructions and irregularities, in the excretions peculiar to it, and to reflect them off itself upon other parts; when other viscera in such cases would become so irremediably affected and diseased, as to be the certain causes of death.

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THE bowels, that is what are called the Abdominal Viscera, and the urinary vessels and organs, being most nearly and intimately connected, either by situation or correspondence of both nutrient and sentient vessels, with this seat of conception; these suffer most by sympathy in all Hysterical disorders. Hence arise Flatulencies, Indigestion, Nauseas, Apathies, vitiated Appetite, convulsive Spasms in the bowels, communicating themselves to the gullet, and producing what is called the Hysterical globe, or a sense of some lump or obstruction in the throat, and Hysterical cholics, succeeded with slight temporary icteric or jaundiced symptoms; and from these disorders in the first passages are frequently produced by sympathy, also pains in the head, giddiness, dimness of sight, &c.

NOR are the secretions less affected in this disease; it being common in it, for the habit to be unnaturally either
costive

costive or the reverse; but most commonly, the former extreme prevails. During the paroxysms, or fits of the Hysteric disorder, there is always also either a spasmodic suppression, or a large flow of pale colourless urine; the urine at that time, though uncommonly plentiful, being almost destitute of these salts and oils, that are naturally intended to be floated off by it.

C H A P.

C H A P. IX.

The characteristic Symptoms of the Hysterical Disorder which demonstrate it to be a Disease of the Principle of the Life itself.

BUT the most singular and remarkable part of this disease of Hysterics is its discharging itself principally and most immediately upon the seat of the fountain of life; from whence, as I have shown, the organ of conception receives its specific character and generating powers.

LIGHT is not more instantaneously dispatched by reflection from a mirror, or by the power which every point of the air has of reflecting lightning *,
than

* There is not a point in the air but what is capable of being excited, by the intense energy of lightning, to reflect it, in all its instantaneous deflections, almost as vividly as where the explosion actually happens. Hence it is seen by those within doors, from north or south, east or west looking windows at the same moment. I have seen the whole zig-zag meanders of a fierce flash of lightning described on the surface of a dish of meat at
table,

than that with which the same fluid under the character and modifications of the vital principle, acts, from place to place, in the human frame *.

IN the Hysterical passion, the accumulated modification of this principle in the theatre of conception is so irritable, that it reacts instantaneously upon that original potential form of life, which stamps it with its procreating virtue.

IT is on this account that this disease so directly and violently attacks all the

table. I have even seen it as if among my fingers, when my attention was fixed on any thing between my hands.

* The moment of willing and of moving any member of the body is undistinguishably the same; so likewise the moment of being touched, and of the touch being felt. But these instantaneous transmissions in our frame, are not confined to such as we have a conscious perception of: They are incessantly transacting: the remotest vibrating artery corresponding with the heart, does not more immediately and constantly feel its power, than the material principle of vitality through its whole form, in our structure feels the permanent influence of its own concentrated epitome, in the centre of its irradiations.

powers,

powers, both conscious and unconscious, of the centre and fountain of life. It extemporaneously assumes the appearance of all the passions, and of the sensible expressions of them ; and inverts them into one another in a moment. Fear and courage, trembling and erection of the spirits, grief and mirth, laughter and weeping, anger and placability are metamorphosed into one another in the twinkling of an eye. The imagination at one instant is perverted into a delirium ; and the next, the understanding is suspended or bewildered ; the senses cease to act, and become intolerably acute by turns. The instruments of the will become convulsed, and violently agitated one while ; and in quick succession, all the symptoms of life are suspended, and the whole faculties both of soul and body will seem as if they were extinct for many hours, nay, for many days together ; insomuch that some have been so unfortunate as to have been buried during the continuance

nuance of an hysteric paroxysm of that kind.

IN short, the whole form in the fountain of life, by which every part of the corporeal frame is supported and influenced, can be so affected by this disease, that every function of life, both animal and vital, shall be so eclipsed as to seem to have totally and irrecoverably ceased, and will then resume all its powers again as placidly as if the person was only awaked out of sleep.

THESE things could not be without form reacting upon form, and a renaisance or repression of these formal powers of life collected in the medium for transmission to new beings, upon the original from which they are copied, and with which they stand in constant communication.

ALL this cannot be performed by the sole energy of a few corresponding nervous filaments ; and yet it could not be
done

done without them: They are the directors, but are totally insufficient for being the conduits or sole conductors of the variously-intended energy of the powers of life.

THE plenum of life occupying and organising every particle and interstice in our composition, discharges its whole nifus, according to the pathic intimations and direction of any nerve or nerves, as instantly, as electricity does through the whole substance of any body that receives its shock. In short, whenever that power which has afforded so much entertainment to the world, in the form of electrical fire, and which is found to exist not only in the *Torpedo* and *Gymnotus Electricus*, but even in the *Blubber**, and, perhaps in many

* A fish common on many coasts, of a circular form, and of the colour and consistence of jellied starch, to appearance, which causes a prickling in any part of the skin that it touches.—This I am told;—but there is a possibility, that the sensation may be produced by some singular vellicating quality in the salts of the animal.

other

other animals, in that form ; whenever, I say, it comes to be duly attended to, in the form of vitality, it will be found to exhibit many phœnomena, more worthy of our admiration and investigation*.

* Every individual is as completely a plenum of light or fire, under the modification of life, circumscribed by its own exterior surface, as determinately, as if it was enclosed in an adamantine shell. And yet the universal energy of that same fluid, and of the atmosphere combined with it, is absolutely necessary to its support every moment ; but the living modification thereof, terminates precisely with our surface.—Note, By *Light*, I mean the substance of that fluid, not that form of action which renders objects visible to us.—By fire, I mean the same fluid. I know some have been so philosophically absurd, as to intimate the possibility that fire was nothing else than an intense vibratory motion of the terrestrial substance of a body heated or ignited ; but the extravagance of this opinion is too glaring to need much confutation. In the focus of a burning glass, light is concentrated into the most intense action of fire, and we know that fluid penetrates all terrestrial things.—The inference is obvious and decisive.—Note, By a plenum, I mean no more, than that the parts of that fluid existing in the substance of other terrestrial bodies, which it permeates, and at the same time occupies organically, is in the same state of fluid continuity as we conceive water is in a sponge soaked full of it.

C H A P.

C H A P. X.

Farther Hints in regard to the Nature and Causes of Hysterics.

IN the two preceding chapters, I have pointed out these symptoms, both sympathetic and primary, which, I think, prove the hysterical passion to be immediately a disease of the principle of life itself. That is, a disease not excited in any parts, by any fixed vicious state either of the fluids or the solids: A disease occasioned by no acrimony, fluxion, or obstruction, settled on the parts where the symptoms of the disease are displayed.

So far is it from seeming to originate from any morbid state of the particular part that gives rise to it, that it seems rather to proceed from the exertion of powers resident in that part, enabling

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it

it to rouse or attack the whole vital powers of the system, in order to preserve and defend itself from any consequences arising from accidental suppressions of its secretions, that may threaten to obstruct topically, or injure that important vessel in its public office and character.

BUT though this is primarily the case, it does not follow, that a long continuance of this disease, during the violent attacks of which the ordinary functions of both solids and fluids are distracted, suspended or reversed, may not injure at last, both the uterus itself, and other parts of the body, that it is often drawn into sympathetic consent with: but this must be considered as a consequential effect, and not as a procuring cause of the Hysteric passion.

AGAIN, in regarding this disease practically, there are many other distinctions to be attended to: for we shall

shall find it either accidental in a constitution perfectly whole and sound, that has been suddenly exposed to some injury of body or mind, at some critical period or revolution of the constitution. In these cases, the persons most susceptible of the attacks of this disease, are generally such as have the appearance of the greatest health and of the fullest habits. After any occasion has given rise to it in such constitutions, it frequently becomes recurrent and habitual, and consequently becomes more difficult to be tamed, and subdued.

BUT the disease is still more difficult to be treated, where it may be considered as constitutional. In such habits it is generally least violent, though most frequent in its paroxysms; and is capable of being excited by any thing that agitates the temper or spirits. In such cases, it is often, though not always, found to have little effect in disturbing the customs of the sex: In some cases it even tends to excite them, and awa-

ken them out of the course of their ordinary periods. These persons in whose constitutions it is in some degree inherent, are commonly of a habit not very full or gross; but of quick sensations, and of a sprightly, active spirit and mind: or else there lurks some latent fretting acrimony in their fluids, in which case, the disease must be considered complexly, as a mixture of the Hypochondriac and Hysterical disorders, fermenting in the same habit.

THE period of life over which this disease extends itself is, from the first bias or direction that the vital powers take, towards impressing and establishing the characters of public or communicative life, in the female constitution, till age gradually wears out the impression. By this date, I do not mean the first cessation of the periodical refluxes of their fluids: for that is a period in which a particular type of the Hysterical disorder rages, as much as in any; namely,

namely, that species of it, by which unhappy females, for a long course of time, even for years together sometimes, are rendered miserable both in their bodies and in their minds, by an unremitting, but constantly-changing succession of pains, and very intolerable sensations of various kinds, in different parts of their body, but especially in their belly (that is, among the viscera and contents of the abdomen,) and in their head.

IN short, under this form and modification of this female disorder, there is no disease, they do not feel the pains of, at times, or imagine themselves affected with. At the same time; their mind is either over-clouded with despondency, and sunk in them with the melancholy idea of their own deplorable case; or their imagination is viciated with ideas of evils and dangers hanging over them, and threatening them, which have no reality, but in their fancy; or

they have an irresistible tendency to talk for ever, of the various endless sensations of their disease; which they think no description can comprehend, nor can it at all, they imagine, be put into language: in short, they know no end of repeating, describing, and talking over their complaints.

PERSONS who live low, are exposed to much cold, who are wanting to themselves, either through negligence, parsimony, or poverty, or who have any latent scorbutic acrimony in their blood, are most subject, upon the second great turn of life in the female constitution, to this species of the Hysterical disease.

C H A P.

C H A P. XI.

*Of that Revolution in modern Constitutions,
which renders them more incident to Hy-
stERIC and Nervous Diseases.*

THE Hysteric disease is one of those which have been accounted much more frequent and universal of late ages, than it was formerly. One species of it certainly is so. But when it has been considered in this light, it has been indiscriminately confounded with nervous disorders in general, or what are called diseases of the spirits, as they are common to men as well as women. Though these are to be distinguished from what is strictly and properly hysterical; yet it must be allowed, that to whatever cause the greater frequency of nervous disorders is to be referred, the same cause must operate in rendering hysterical complaints

plaints more frequent also. So that what I say upon this subject, will be equally applicable to the source or remote cause of nervous disorders, (commonly so called,) in general, and of the Hysterical passion in particular.

WHATEVER is the cause of the general change induced upon the human constitution, within their sphere of observation who admit of the fact; I think it must be allowed to be a change, upon the whole, for the better and not for the worse. For this reason, I cannot help charging the Academy of Dijon, with being guilty of great weakness of judgment, (as such societies will sometimes be,) when they conferred their premium upon that flimsy oration of Mr. Rousseau, in which he extolls the constitutions and manners of the ancients so highly above these of the moderns.

I DARE presume to affirm, that the ingenious declaimant never once reflected,

ed, that he owed all his sophistical ingenuity, with which he supported his paradoxical arguments against the superiority of the moderns, to his nervous, whimsical, modern constitution: nor ever once consulted with himself, whether he would prefer a robust, athletic, hard-tempered constitution, with a blunt, impetuous, unsentimental spirit, to a more delicate, nervous, sensible frame, connected with a sentimental spirit, capable of receiving a luxurious impression from every beauty of nature, and of entertaining his own wild, fertile imagination, with the debauching of an Eloisa, the rearing of an Emilius, or with the ordination of a Savoy Curate, with a character suitable to his own ideas.

Most certainly, generally speaking, the powers and pleasures of the imagination and mind, follow the habit of the body; nay, if I were to say, that the improved constitutions of bodies-
 politic

politic were connected with it too, I believe, I should not err much from the mark. I do not know, whether the bodily constitutions of Alexander and Cæsar, would have been proper cases for the sentimental philosophising minds of Aristotle or Cicero; but I am pretty certain, that neither of the latter would ever have distinguished themselves greatly at the heads of armies. If we cannot so indefatigably as the ancients scamper over hill and dale, enjoying the butchering pursuit of the chace, or of routed legions; we are at least as well qualified as they, for walking in fields or gardens, and for enjoying the natural delight infused by the prospects of rocks and fountains, mountains and plains, forests, and fertile fields. With the constitutions that moderns have, soldiers, though perhaps they cannot draw the bow so bent, or dart the lance so far as the ancients, they are as athletic and sanguinary, as there is occasion for in the happier ages of
 declined

declined barbarity, and improved humanity of mind.

As I am about to assign what I think the most probable reason for the revolution, which has happened in our constitutions within these two centuries, I hope the reader will forgive this short digression by way of an apology for them.

OUR country is the same that it was always, and so I believe is our climate; excepting what changes in it may result from the improvements it may have received by the extirpation of woods, or the cultivation of lands; but these are rather in our favour. Our food, and our manner of living, then must have been altered. They are so. Since the trade of the East and West Indies opened upon us, a great alteration of both these has been introduced, especially among those who are above the labouring ranks of life.

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THE alterations of dress in favour of elegance and cleanliness, have greatly circumscribed our exercise. A person who has contracted a taste for cleanliness of dress, is naturally restrained from either the quantity of exercise, or the varieties of it, that he would otherwise engage in. This soon grows into a habit, which fixes that quantity of exercise that we find either agreeable or necessary. As exercise has a great effect in strengthening the solids, encreasing the heat and circulation of the fluids, and in short, in winding up the springs of life; so comparatively, inactivity must be accompanied with a more relaxed and less indefatigable constitution.—Such constitutions as we acquire or form to ourselves, such do we transmit to our descendants.

Now, though this is certainly the case, it does not follow, that our constitutions with the quantity of exercise they

they are formed for, are less qualified for holding out to the latest term of life, than those of our forefathers. I believe there are as many die of a good old age now, as there did then. But on the other hand, I am afraid it cannot be said there are as few die in infancy now, as there did then. This leads me to say something on that subject.

C H A P.

C H A P. XII.

The Subject continued. The Effects of the Abuse of Sugar considered; particularly in regard to Infants.

IT is to America chiefly, and not to Asia, that we owe the principal cause of the alteration of our constitutions, and the encreased mortality of infants, unknown in more barbarous times; the populousness of which times consisted in the healthfulness of infancy then, and in the greater proportion of those, who arrived at the years of maturity, and not in the greater number of those who lived to a great old age.

A DELICATE infant cannot bear the same exposure, hardships, neglects, and various mismanagements, that would only contribute to harden and temper one of a more vigorous robust frame.

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Therefore, the children of more delicate descendants cannot sustain the same food and education as formerly ; while at the same time one constant ingredient of their food, which old and young were equally strangers to, in former ages, is sufficient to enervate the strongest stamina of infancy.

It is not to the universal use of tea, nor to the warm water in which it is infused, that the present race of mankind owe the greater imbecillity of their constitutions ; but to the universal use, or rather abuse, of sugar in infancy, and the immoderate quantity of it used by the female sex especially, as the principal ingredient in their tea,

SUGAR itself is so far from being unwholesome or bad nutriment that, I believe, it is on account of its highly nutritive quality, that it is capable of becoming so noxious to our constitutions. Even in its coarsest, which is
its

its most wholesome form, its nutritive parts are too concentrated and separated from its grosser parts to be safely used, with that freedom as food which is more mingled with recrementitious parts, such as the various farinaceous grains of which bread is made.

It is well known, that it is the nutritious parts of vegetables, (the saccharine, or what may be converted into saccharine parts,) principally, if not solely, that are capable of undergoing either the vinous or the acetous fermentation; and it is also known, that such substances separated from their grosser parts, and properly diluted, when they are not put into such circumstances and such a regimen as favours the vinous fermentation, are apt to pass directly into the acetous fermentation, and to generate an acid; to which nothing contributes more than a greater degree of heat, than is required to promote the vinous change; which the heat of our bodies is.

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WHENEVER, therefore, we mingle more of such a substance as sugar with our food, than our stomachs are able to digest, before it ferments and degenerates into an excess of acidity, (some is necessary in all well-regulated digestion,) then the superfluity must weaken the blood, and encrease the saline parts too much, in proportion to its unctuous and other parts. Not only so, but when a superabundant quantity of acid enters the blood, it necessarily weakens its crasis, by assuming other parts of the blood, tending to other changes in its healthy state, in order to saturate or neutralise it, for no acid can remain any time in the blood, (such is the nature of its digestions,) unsheathed or unneutralised, without great and immediate detriment to the constitution.

BUT though little acid can be detected in the blood by the more common processes of chymistry, yet it always

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is

is there, in a neutralised and more refined state; and an imperfect neutralisation of any or all of that acidity, is the immediate cause of all these complaints which arise from what is not very improperly called coldness or weakness of the blood.

CONSTITUTIONS, then, formed on that excess or deficiency, call it which we please, in infancy; derived also from such constitutions as are formed upon the same plan; and again, habituated through life to the excessive use of the same very ascescent substance, must differ very essentially in point of strength, vigour, and heat, from constitutions uncooled, and not relaxed by any superabundant fuel for acidity in their system of food.

BUT though I have demonstrated a cause adequate to the effect of reducing our constitutions in point of strength, below the standard of our ancestors;

tensors; it does not follow, that our feelings, sensibility, &c. are inferior to theirs. On the contrary, it would seem that oils concocted (as they certainly are,) out of such salts, are less gross, finer, lighter, and more irritable than the grosser, and more torrifed oils in hotter constitutions. Besides, the excess of salts verging more towards ascessency in our blood, must, by the irritation they produce, encrease the sensibility of the sensible parts of our systems; which, upon the whole, accounts for the encreased frequency of both nervous and hystERIC diseases *.

* To sugar, that leading cause of the change of both our constitutions, and perhaps of the types of many diseases, ought to be added; the great change of our cookery and high seasoning; as also the greater use of spirits. All these have a present temporary effect, in whetting the appetite, assisting a more languid digestion, and augmenting the circulation. But when that effect is over, it leaves the natural powers of life as much sunk below the natural mark, as it raised them for a while above it.

BUT before I dismiss this part of my subject, I must touch a little more particularly on the general cause of the increased frequency of infant-mortality.

C H A P.

C H A P. XIII.

Of the Cause of the encreased Frequency of Infant Mortality.

WE are all born mortal; but the death of infants, though no doubt comprehended in the plan of infinite Providence, is no part of the plan of Nature, more than violent or accidental deaths are. All infants are born to live, and rarely bring into the world any defect of constitution to occasion their early death. That is a large and melancholy roll, to be charged to the account of involuntary mismanagement and ignorance of the constitutions of children, both in health and in sickness.

IF infants require sweetened aliments at all, the mother's milk is certainly the proper standard, beyond which no food that is administered to them ought to be

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dulcified.

dulcified. Children, who are nursed by a healthful mother, or proper nurse, need little or no food, but what they draw from the breasts, for some months. The longer they are kept to that, as their only or principal nourishment, the stronger and more vigorous their constitutions become.

IN ancient times, when women had almost none but domestic engagements upon their hands, children were rarely weaned, till they either gradually weaned themselves, or till the mother's attention was awakened to a fresh object of her maternal sollicitude and care. Now customs are greatly changed; I cannot indeed say, in this respect for the better; but the dissipation of the men is chargeable with this folly, in the first instance: For if they sought for their happiness more at home, the women would rarely seek theirs abroad. But however, when mothers do not nurse, many circumstances render it dangerous.

ous, particularly in great cities, to employ other nurses, especially abroad. For these reasons, children are treated as little and as short while with their natural food as possible, if they are indulged with it at all ; and thus the tragedy of infanticide begins.

WHEN then the infant cries from gripes,—it is hungry, and some spoon-meat is administered, as sweet generally as that delicious poison sugar can make it, which, by that bribe, it swallows greedily.—Till the fresh-taken viands begin to ferment, the child is quiet,—not because its hunger was assuaged, but because the acid which occasioned its pain, is sheathed and diluted by what it has taken ; when that likewise begins to ferment, the cause of its pain, and its crying, recur with double violence ; and then fresh materials for encreasing and sharpening the acidity is thrown in. Thus, in the first place, the child's sleep, upon which it ought to digest and thrive, is broken and inter-

rupted with pain, the child having no intervals for it, but in the short spaces between receiving fresh food, and the time of its turning to vinegar in its stomach *.

THIS acid not only curdles the milk in the stomach, in such a manner, as to congeal the colostrum or curd, into tenaceous coherent lumps; but in passing from the stomach into the intestines, it corrupts the bile, which was intended by its alkalescent acrimony to

* They have very imperfect ideas of the nature of our animal digestions, who think they can be performed without a due quantity of acidity, or who imagine there is no acidity where the senses do not discover it: from whence do such physiologists suppose, comes the saturating acid of the neutral salts of the blood? A strong bias to acidity, often lurks in substances which discover none to the taste. A chyle of such quality, must constitute a weak imperfect blood.—Though no acid is discovered in the blood, yet does not the abuse of acids ruin many constitutions, who imprudently indulge in the use of them, to preserve the shape, and prevent or cure corpulency?

assist

assist digestion, or it renders it insipid, by the acid sheathing itself as much as it can with its alkalescent parts. The bile thus mixed and overpowered with the acid, becomes green, a sure sign of its having become vapid and unfit for digestion ; and therefore it is purged off, mixed also with the white indigestible curd, a sensible interpretation of the cause of the infant's sufferings and pains.

NOTWITHSTANDING all this, the tragedy proceeds.—The infant's bowels become weaker and weaker, their original native dewy humidity is changed into viscid slime, which obstructs the orifices of the lacteals and absorbing vessels daily more and more. —The corrupted bile, the curd, that viscosity and any natural recrements of digestion which are in the passages incorporate, and are baked together into a gluey consistence of a clay colour, which the weak intestines cannot expel:

pel:—their efforts to do it, throw the whole infantile frame into convulsions, which soon finish the tragedy.

AT other times, the infant's bowels are so weakened and rendered so irritable by the above causes, that it is thrown into colliquative purgings; by which, not only its food runs through its bowels undigested, but its own fluids are drained off also, till its vitals are exhausted, and it is left an emaciated corpse.

By another as certain, but slower road to death, the deadly quantity of acid kept up in the infant's bowels, enters the lacteals imperfectly saturated, coagulates the chyle and the lymph it mixes with in the mesenteric glands, obstructs them thereby, and renders them impermeable and schirrous: the child emaciates, its belly swells with gross impassible vapours, distending its intestines, and

and it dies sometimes with and sometimes without fits.

THESE are some of the most palpable progresses of this cruel acid, so fatal to infants. But, though they escape these and the like direct effects of it, how often does it weaken their constitution, so that they either fall sacrifices to the first accidental, or the first epidemic disease incident to children, that they are attacked by, or become rickety, scrophulous, and pine away under cachectic diseases?

THEY have many escapes, under the present system of rearing infants, who arrive at manhood or womanhood; and they escape well, who bring no more with them to that æra, but nervous or hysterical constitutions.

C H A P.

C H A P. XIV.

Of the immediate Source and Seat of animal Heat.

I H A V E already discoursed of the fountain of life, considered as the internal directing principle of both conscious and unconscious, or of animal and natural life, in the whole, and in every individual organ and part of our system, according to their specific natures and similarities. It is now requisite to ascertain, where immediately, that quantity of motion, in that animating element of our frame, is generated and supported, that is necessary to qualify it for exhibiting all the symptoms and phenomena of life.

ACCORDING to the different natures of different animals, there is a certain general specific degree of activity proper
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to each kind, in which that fluid must be kept, to enable it to display all its functions, and act obediently to the seat of influence, thro' the whole system of each individual. The nature and quantity of this motion, of that moiety of the matter of light, or fire, which acts as the principle of vitality in every creature, according to its different nature, is ascertained by its degree of sensible heat. The question therefore is, where? In what part of our frame? In what viscus, or in what system of our materials is this elaboratory, in which is fed, preserved, and kept up, this flame of life, this vital heat?——I answer, in the blood.

THERE can be little doubt, but, that the fountain of heat, where-ever that is, and the fountain of vital motion, in the animal system, are the same.

THE ancient but exploded physiologists of the Peripatetic and Galenical schools, were very nice and subtile in their reasonings

sonings upon the subject of the *calidum innatum*, or the native heat in animals, which they distinguished and subdivided into no less than six heads. Perhaps we now think there was more subtilty than utility in these refinements, and that they would have sped better in medicine, had they confined their reasonings to experiment and observation. But upon the whole, I do not find that these antiquated physicians were either less successful practitioners; or, in their physiology, more frequently obliged to have recourse to occult qualities, than the moderns. Facts seem to have been as carefully attended to by them, as by us; and if they made fewer experiments, they at least made as profitable an use of these they did make, as we do of ours *.

No

* There is a manner of citing and appealing to *facts*, become very fashionable, among people too, who pretend to be friends to science, as if they ex-
cluded

No solid or body, whose constituent parts keep a permanent relative connection with one another, can either generate or retain heat in itself. A solid continuing such, or, after fusion by heat, returning again to solidity, may be heated passively, but it cannot retain heat, far less can heat originate in it*.

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cluded reasoning upon them. Such people must have very imperfect ideas of the nature of facts, and of their subservience to knowledge of any kind.——No absolute facts fall within the observation of creatures. All facts disclosed to us are relative, systematic or mechanical, and therefore contain always a double reference; as effects to their causes, and as causes to their effects. In the same manner, as every link of a chain, except the terminating ones, is always immediately connected with other two.

* We have many and various instances of fluids generating heat in themselves, but not one of a solid's doing so. We may as well attribute the heat of hot springs to the heat of the rocks the water may happen to pass through the fissures of, as attribute the heat of the blood to the pipes or vessels it flows in.

It seems evident to me, from the residuums of both Bath and Bristol hot waters, which contain a considerable proportion of unsaturated alkaline earth in them, that, so impregnated, they must pass through veins of sulphur, or
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If this circumstance had been attended to, it would have saved enquirers many experiments and ingenious conjectures, made in order to discover what it determines.—If this does not expressly prove, that the seat of vital warmth, is in the blood; it at least brings us so far on the way towards the discovery of its seat, by proving it is no inherent principle in the animal solids, and by obliging us to look for this elaboratory of heat in the fluids.

AT the same time, it bears some tes-

of some substances which emit acid steams; but not through a sufficient quantity of that acid, to neutralise all the earth in these waters. By the effervescence between the acids, and such a quantity of the earths as are found formed into neutral salts, is probably produced both the heat of these waters and their sparkling, or emission of acid vapour, which cannot extricate itself till the waters break out into correspondence with the common air, but which is generated in all effervescence according to the manner explained in my note on Fixed Air, in my discourse on the Causes of the Circulation of the Blood.

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timony to the sagacity of the obsolete physiology of the Ancients, who determined the *humidum radicale*, and the *humidum influens*, to contribute essentially towards the support of the *callidum nativum*.

BUT the circumstance of mere fluidity, is not more sufficient than that of solidity for constituting any body the subject of permanent heat. Heat can no more be kept alive in water, or in quicksilver, than in a bone, a stone, or a piece of metal. The maintenance of heat necessarily depends upon the mutability of the nature of the fluid it acts in, and its power of changing the nature and properties of that fluid, or certain constituent parts of it, with such energy, that the act of inversion or changing the nature of such particles, shall generate as much motion in the fluid Light, in performing the change, as was spent in bringing the particles changed to

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that critical state in which the change passes upon them.

WHEN this immutation is executed in all the parts of the fluid, the heat generated and maintained in them during the process, would languish gradually, and extinguish like a lamp without oil, unless the fluid was constantly fed and repaired with fresh matter, capable of being successively disposed into the animal mutations, by the particular degree and kind of heat and motion, into which it is introduced.

THE blood, then, and it only, is that specific fluid in the animal constitution, which has these characters requisite to constitute it the theatre and immediate organ of the support and preservation of animal heat. It is not only a fluid, that, without the interposition of glandular influence and secretion, has been changed into blood, from materials

terials that had not these properties before, and that is again in a disposition to be divested of its character of blood, and of putting on the properties of the secretion of whatever organs it is presented to; but it is in itself, a fluid consisting of, at least, three different crases blended together, capable, probably of being resolved into one another, and yet still constituting essential parts of blood.

IF we add to all this, that it is a fluid kept in constant progressive motion, and in mechanical, as well as specific internal, motion, we will find all the satisfaction and evidence we can desire given us to conclude, that it is the constant generator and supporter of that specific heat, in that moiety of the ethereal fluid, which, under the influence of its directing fountain in the seat of sensation and volition, acts as life through our whole frame, according to the various dispositions

sitions and similarities of the different constituent parts of our composition.

THE neglected Ancients made a seemingly unaccountable, and probably therefore, deemed by many, a very foolish distribution of the different parts of the animal system, into *hot* and *cold*; calling the Heart, with its Arteries and Veins, the Liver, the Lungs, the Kidnies, the Muscles, &c. *hot*; and the Bones and Cartilages, the Ligaments, the Membranes, the Brain, the Nerves, &c. *cold*; while they constituted the skin of a middle temperature between the two. But if we reflect that they founded this distinction upon the different colour of the parts, as they exhibited the appearance of the red bloods being more or less predominant in them; and if we advert, at the same time, that the parts called cold, may passively, or by communication only, be kept as hot as the parts where heat was supposed

posed immediately to reside, without their possessing the property of cherishing their own heat ; then we will perhaps admit, that this neglected distinction was not quite so whimsical or groundless as at first sight we may be disposed to think it.

C H A P. XV.

Of the Nature and constituent Parts of the Blood.

AS I have taken occasion from my subject, to determine that primary and essential office of the blood, namely, the support, and maintenance of the animal heat; I wish I was likewise able to say something as decisive of its structure and analysis also. But as I cannot be so confident of doing that, I shall only presume to offer some thoughts towards ascertaining these points. Both the analysis, and the structure of the blood, fall each under three divisions.

I HAVE little hesitation in saying, that analytically, the blood consists of phlegm or water, salt, and oil.

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OF its phlegm, I observe, that though it is water, yet it is something more. All aqueous vapour that has a tinge of smell, is either mixed with some very subtile essential oil, that cannot be otherwise distinguished, but by its flavour; or else, which I am more inclined to think, the aqueous vapour itself, though it has not lost its character of water, is so far changed or advanced towards a change into oil, as to have smell. Such is, what is called the *spiritus rector* of vegetables.

THE saline part of the blood, has something well worth consideration in it. We know, that in a sound state, all the salts in the blood are in a ^{su} natural state, though a large proportion of the salts of our food (I mean our vegetable food,) are either acid or acescent*. But the question is,

* Indeed, all natural vegetable acids retain annexed to themselves, an earth equivalent to what would neutralise them, yet in such a singular manner, as not to

is, how the acid salts we take into the blood are neutralised? and from what stock of materials in it, are they furnished with their alkaline or neutralising basis?—Again, though a neutral salt necessarily implies the existence of an acid, why are the blood and animal fluids so ready to discover their alkali, and so difficult to exhibit any signs of acid? These points well explained, would tend to give more insight into the animal processes.

OF the animal oil in the blood, it is to be considered, whether it is not all of one kind, or at least tending to one height of elaboration; which in my opinion, (I will call it no more,) tends to solidity or fixation. When I say so, I do not forget that the collect-

destroy their acidity. This is demonstrated, by a very simple chymical process, to be the case with crystals of tartar, which yield a large proportion of alkaline salt of tartar.

ed oils in the body have some small appearance of a different character from one another. But what I principally refer to is; what is exhibited in the analysing of oils, where the fire divides them into separate appearances: such as empyreumatic oils, and that which remains fixed in the coal, or *caput mortuum*. These are not to be understood to belong to the oils, as animal, or to any one part of them more difficult to rise than others. But as all cannot rise together, these particles which are retarded by their situation from rising first or early in the alembic, by being longer subjected to the fire, necessarily acquire these changes; not because they were naturally heaviest, but because they were undermost, and therefore necessarily scorched in different degrees.

My reason for not including earth as one of the principles of which the blood is composed, I have hinted at before.

before. We have no evidence, nor any reason to suppose, that earth exists in the blood, in any other form, but either as a neutralising part of its animal salts, or as an organ of the phlogiston, when these salts, probably by the mediation of aqueous particles, are inverted into particles of oils. For that the earthy remains obtained from the coal of a distilled quantity of animal or other oil, is not any part of it that was incapable of dissipation by fire, may be demonstrated by the total dissipation of that oil in flame, when burnt by a wick; while the same quantity of oil distilled in a retort, will leave a large portion of coal, incapable of ever being elevated into flame; which when calcined, will leave a portion of earth, which no fire can either elevate or dissipate.

PROPER infection is one or all of these principles of the blood subtilized, acuated, and rendered highly volatile, by some accidental animal process, which
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the common powers of the constitution acting on its fluids, neither tends to ; nor, where such miasmata are introduced, can it assimilate or overcome them. These therefore act as a ferment in the fluids they mingle with, and invert some of them into its nature. Just as wort, being incapable of reducing the spirit involved in yeast, but at the same time, containing in it principles or combinations similar to these the yeast or the active spirit in it was produced out of, these act upon the mass, as a ferment, and insinuating an arrangement of particles and activity similar to its own, it spreads its infection through all the particles capable of immutation into the same form.

It is highly improbable, therefore, to suppose, that any poison or virulence, except such as is of an animal nature, can communicate proper infection. Other substances, or their effluvia, may kill where they enter, or poison by an
improper

improper contagion ; but such noxious bodies cannot propagate or multiply themselves in the animal constitution.

THERE cannot be any proper infection in the air itself, (unless by becoming accidentally loaded with corrupt animal effluvia,) marsh, miasmata; or in any effluvia that are incapable of assimilating animal fluids to their nature. It is impossible for these to affect the human constitution, in any other manner, than as non-naturals. They may produce either such gradual or sudden changes upon the relative action of our solids and fluids on each other, as may dispose them to this or the other morbid consequence ; but they can introduce nothing into the constitution, that can act as a ferment. Nature is progressive, but never retrograde in her operations : it is easy for her to produce spirit out of must, but she will never revert spirit into must. Arsenic, or mineral effluvia, may kill such as it reaches,

reaches, but neither of these will ever become contagion in the blood.

As the blood consists of three principles, so in its structure as blood, it is known to consist of three distinguishable parts ; namely, coagulum or crassamentum, serum and red colouring particles ; much in the same manner as the animal secretion, milk, consists of colostrum or curd, whey, and cream.

THAT some of all the principles of the blood enter into the composition of each of its parts, there is no reason to doubt. But in what proportion each partakes of the three principles, is not known ; nor has it yet become a subject of enquiry, so far as I know, though it seems to me the most probable method of attaining that insight into the mysterious nature of that fluid, that would be of most use in medicine ; for without that, we shall not be able to comprehend how a fluid of common principles,

principles, arranges itself, where-ever it goes, under three such distinct forms.

THE coagulum distinguishes itself by two properties from the other parts. These when sufficiently weighed, and the inferences collected from them which they yield, may contribute to throw some light on the subject.

FIRST, the coagulum is a part of the blood, which is coalescent under the animal degree of heat; and that this coalescence is the direct effect of the animal heat, is proved by the encrease of it, under an encreased degree of heat, as in all cases of inflammation, or inflammatory fever. The coagulum of the blood being much of the same nature with the mucilage of gums, it may be pretty certainly determined to be, a combination of oily and aqueous particles, rendered tenacious by some of the salts of the blood, in which there is a considerable excess of aqueous parts;

parts ; but as the other parts of the blood consist of the same principles, and and as the heat in the blood is the cause of the combination, it would seem to follow, that the coagulum must consist of such parts of these principles, as are most rarefied by the heat of the blood.

THE second distinguishing property of this part of the blood, seems to favour this inference. It is the lightest part of the blood. It is plain, that it is lighter than the serum, for it swims in it. It seems also pretty certain that, if not always, at least in some circumstances consistent with life, it is lighter than the red particles of the blood : for in all cases of siziness, or where there is an inflammatory crust, it in part rises to the surface above it. It is surprising in some highly inflammatory cases, how quickly and sensibly to the eye the red part descends, and is in a manner squeezed out of its place, by the coagulum at the surface.

ONE use of the coagulum seems to be a provision of all-provident Nature, to entangle the most rarefied parts of the blood always into this state, to prevent their distending the vessels too much, by their expansion, if they continued loose, and so disturbing not only the progressive motion and the secretions, but, perhaps by that means, subverting the whole function of the system. That the unentangled effluvia in its natural state, does always in some degree, and in some cases, remarkably distend the vessels, is without doubt; but that the tenacity of the coagulum, restrains it, is also self-evident. If then all the most rarefied effluvia entangled in the coagulum, was let loose in the vessels, it would certainly choak the circulation and animal processes entirely*.

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* The formation, extension, and multiplication of the vessels in the embryo during gestation, or its state of formation, seem to be another great end, to which Nature applies the coagulum of the blood; and it must be

THE serum may be considered as much of the same nature with the coagulum, under the difference above specified. Its elements are in such a state, that the highest heat of the blood consistent with life cannot rarefy them so as to make them coalesce. That it is only the want of a sufficient degree of heat that prevents it, is demonstrated by the serum's coagulating, when a stronger than the animal degree of heat is applied to it, and a certain portion of its aqueous particles evaporated.

be applied the same way, during growth : besides answering the occasional repairs the vessels require. We have a kind of demonstration of this application of the coagulum, in the cases of wounds and sores. Though the fibrous part of the blood is a very incorrect appellation of the gluten, merely because it is a substance that will rope in any direction ; yet certainly, when it escapes out of, and covers the orifices of divided vessels ; its tenacity expressly qualifies it for being stretched into new vessels, by the fluids behind pushing forwards into it ; while it, by its ropy glutinous quality, will be extended without losing the adhesive continuity of its parts ; in the same manner as glass, under a certain degree of heat, can be blown into small tubes.

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HERE then, are two pretty nearly equal quantities of the elements of the blood, whose most specific difference is, that the animal heat brings the one, and cannot bring the other, into a state of gelatinous coalescence. While the serum preserves the necessary fluidity of the blood, the gluten mingling every where equally with it, entangles its volatile parts, and restrains its tendency to expand into a too elastic state, by the degree of heat necessary to be kept up in it, for the universal support of the vital actions through our whole frame.

It must not be omitted, that there is some difference of colour between the coagulum and the serum; though both are transparent, yet the former is more so; the latter having a tinge of green, which it undoubtedly partakes of from the bile that mingles with the blood.

THERE

THERE are three peculiarities in the red part of the blood. 1st, Its colour; which I cannot pretend to account for. 2d, It is not a fluid, but exists only as a tinging substance; and thirdly, which is very singular, that it is in a manner confined to the gluten, and is almost wholly entangled in it. It would seem as if such a tenaceous medium as the gluten, was necessary to suspend it equally, and to keep it from precipitating or combining into some more solid form.

WHAT is desireable to be further known of this part of the blood is, Whether, as the blood in general is the preserver and propagator of animal heat, it in particular is not the more immediate seat of it? This we know, that the heat and colour of any part keep pace with each other; and whenever we see the colour of any part of the body heightened, we generally determine, without

the necessity of feeling in all inflammations, that its heat is encreased in proportion.—Whether is it not most immediately elaborated out of the bile? This, if it is so, would be some apology for the opinion of former times, when the liver was supposed to be the great laboratory of the blood.—And—whether are not its particles the most predominantly unctuous ones in the blood?

As to the determining aught of the nature and use of the red particles, from the examination of their form by the microscope, or as to the possibility of catching any single constituent particle by itself, so as to ascertain its form, I am in doubt; notwithstanding the ingenious attempts that have been made that way. They who are curious to know more of this animal principle, ought to find out a menstruum, which would not only wash it from the coagulum,

gulum, but which it could be separated from afterwards, by evaporation, as is done in procuring colours from flowers, &c. Then it might be put to examination by itself.

C H A P. XVI.

Cf Irritability, Spasm, Life.

AS these terms have been in modern times adopted into physiology, and make at present the most considerable figure in our theory, both of health and of diseases, in senses either supposed to be formerly unknown, or as alluding to phœnomena in the human constitution, that were wont to be understood and spoken of, in another manner; and as what these terms seem to allude to, have a direct and immediate connection with the subject of hysterical, hypochondriacal, &c. diseases, I find it therefore requisite to enquire into the meaning and application of these terms.

I R R I T A B I L I T Y.

WE are indebted to the truly learned and indefatigable physiologist, Dr. Haller, for this term. It is meant, I apprehend,

prehend, to denominate some natural property, peculiar to living animal substances, particularly to their ultimate vascular solids; too great a degree of which property, constitutes a diseased affection of them. The sensible idea that the word irritability conveys, is that mobility of any substance (of a glass of jelly, for example,) that manifests itself, by a tremulous motion through the whole, when it is touched in any part; and it implies a loose connection of the parts of such a substance, compared with the firmer compages of any more solid body. The idea conveyed by the word, is also very properly applicable to a fluid acting in or confined to vessels, which undulates in all its parts, when the vessel that holds it is struck.

It is analogous to electricity, in that the electrical fluid, contained in the electrified body, is shocked through its whole substance instantaneously, on

communicating with the conductor. It seems to differ from electricity, in that the solid itself is not apparently moved, by the electrifying of the fluid contained in it. But this is only a seeming difference; for in fact, every living subject that sustains an electrical shock, feels a violent impression made upon its whole substance.

IRRITABILITY is also analogous to elasticity; but seems to differ from it in this respect; that the irritation of the substance of an elastic, seems confined to the point where it is struck. But this also is only a seeming difference; for when an elastic body is extended and properly attenuated, as in the spring of a watch, or in a musical chord, then elasticity shows itself to be precisely analogous to irritability in its phenomena.

IRRITABILITY, as applicable to the living animal frame, may be distinguished

tinguished into *insensible* Irritability, or that unfelt constant commotion of the animal fibres, which is remarkably discernible in what is called the vermicular motion of the intestines; And into *sensible* Irritability; in which the perception is easily shocked, so as to disturb the whole frame by every accident that affects the senses unexpectedly. This species of irritability is one constant concomitant symptom of the hysterical disease.

IN attenuated subjects of irritability, such as animal fibres, it implies a vibration upon irritating ~~contact~~ *concussion* back through the whole length of the fibre. —It implies that the fibre itself is in a state of tension or distention sufficient to brace it, and preserve it in that constant state of elastic mobility, which is the characteristic of living animal fibres. —An actual state of irritability in living animal fibres, implies a constantly influent, active substance, keeping
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ing the fibres tense,——and it implies an active substance, that by its motion constantly plays upon the fibre, and keeps it moving. All these causes cease upon death ; and therefore upon death, an animal fibre loses its elasticity.

It is admitted in fact from observation, that the fibres of living animals are in an elastic state ; for when they are divided, they shorten and retract. But most physiologists are more disposed to refer this to some occult principle, than to examine what natural or mechanical principles exist in the living animal, sufficient to produce the effect. The animal fibres have all the appearance of being loose and involved, and not stretched between two points, or tight in the sense that a musical chord is. A cord of any kind can be rendered elastic only two ways, either by *tension* between points ; or by *distension*, swelling their substance in thickness beyond the natural size, which in death they

they collapse into; therefore in life, there must be some natural cause of their greater distension.

THE immediate cause of this will appear more plainly, when we advert that the fibres of a dead animal may have elasticity restored to them, by the heat of roasting or boiling. The fibres of a piece of dressed meat cut up warm, retract themselves more sensibly and violently than even living animal fibres do: Therefore, it is natural to conclude, that the animal heat, and the other circumstances of the internal agitative and progressive motions of the fluids in them, and of the etherial fluid in both, are what give elasticity to the fibres of living animals; or rather is, what in them constitutes their elasticity. Therefore, it must be an inferior degree of elasticity, as I have noticed before, that encreases the irritability of animals, so as to render it a disease.

THAT

THAT degree of irritability constituting a disease, ought to be remedied either by *depletion*, by which the tension is relieved; by *incalescence*, adding strength and competent action to the fluid, whose weakness most immediately produces morbid irritability; or by *condensation*, encreasing the firmness and contractile quality of the solids themselves.—The judgement of the physician must discover which of the modes of assistance each constitution requires.

IRRITABILITY may, with propriety enough, be distinguished into solid, viz. as it is discovered in elastic bodies; and semi-fluid, viz. such as manifests itself either in jellies, or such as is discoverable in substances composed of a mixture of solids and fluids, like living animal substances: Therefore the way to diminish the latter species of irritability, which is the greatest, or at least the most susceptible of agitation

tation from flight causes, is to strengthen the parts both solid and fluid, so as to make them approach nearer the consistence and firmness of the former.

—In how many things do mechanics instruct the physician? Q. What are the ratios of the mechanical processes of dressing leather? Q. What is the reason that fire, which is known to expand all bodies, should seem to shrivel many bodies when they are cast into it, such as Cloth, Paper, Parchment, &c. &c.?

S P A S M.

THE phœnomena to be attended to in medicine, and which it is requisite every intelligent physician should form some adequate conception of, in order either to his assisting and supporting nature, or relieving it with propriety, are perhaps some of the most obscure in nature, and therefore have little need to be perplexed with vague and indefinite terms.

THE

THE etymological sense of the word *Spasm*, is much the same with that of *attraction*; and, of late especially, it has been used much in the same loose indecisive manner, to denominate occult powers, the nature of whose action it not only does not define, but of which it gives us either incompetent or false ideas.

FORMERLY, in medicine, the term *Spasm* was appropriated to denominate the involuntary, painful action, or contraction of muscles, or muscular fibres; and as such, it became a very distinct head for the arrangement of a certain series of diseases under it, produced either by irritation, (which is divisible into *repletion* or *acrimony*,) as in the cases of Epilepsies, Wounds, Worms, Dentition, Acidities, and Coagulations, Obstructions of the first passages, &c. &c.—or produced by a decay, or constitutional weakness, or irritability of the habit, such as hysterical, hypochondriacal,

driacal, &c. diseases, many asthmas, autumnal *, and bilious complaints, and various morbid phœnomena occurring in cold, relaxed constitutions, or constitutions exhausted by intemperance of any kind.

As I am upon this subject, I shall take the liberty, which I flatter myself, will not be objected to, of digressing so far from prosecuting the subject physiologically, as to offer some practical marks for distinguishing spasmodic from inflammatory pain. This is a point I do not remember to have seen so particularly attended to, as its importance requires. As Spasms in nervous solids, and parts whose action and motions are not sensible and voluntary, like those of the muscles, cannot be by the sense

* Under what are called autumnal complaints in northern climates, are to be included all similar disorders in equatorial climates, where the heat is always nearly the same.

distinguished from pain arising from other causes ; yet, as they ought to be treated very differently, it is, I apprehend, a matter of much consequence, to attend to the following short and precise marks, for distinguishing spasmodic from inflammatory pain.

SPASMODIC pain, let it be ever so excessive, seldom or ever excites general convulsions, whereas an extreme degree of inflammatory pain is very apt to produce them.—Spasmodic pain is often desultory and wandering; when any noble or vital part is oppressed with it, it is generally relieved by a translocation of the pain or spasm, to some less vital part; whereas inflammatory pain never shifts, till it is relieved either by resolution, suppuration, or mortification of the part.—Spasmodic pain is generally attended with a low, small or sometimes languid pulse, and with little or no fever: inflammatory pain, is always attended with a considerable
degree

degree of fever, proportioned to the magnitude or quantity of the inflammation, unless the seat of it is in some part which immediately affects the free action of the nervous system.—When inflammatory pain terminates in mortification, the mortification is confined to the seat of the inflammation, or at least commences there: but spasmodic pain of the same fatal tendency, generally spreads an universal languor over the whole vital system, and is apt to produce an universal stagnation of the circulation, and death of the other members, almost as soon as in the original seat of the pain itself.

IN modern physiology, by, I cannot help calling it, a very unjustifiable prostitution of terms, Spasm is used as a term of indefinite application, not only to some unintelligible actions of the solids of living animals, but to the very action of objects upon our senses. Two different colours cannot make more

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discrete

discrete impressions on the sensible fibres of the eye, than heat and cold do upon the sentient cutaneous nerves; yet by the present physiology, both are not only indiscriminately confounded under the denomination of Spasm; but the one, according to the present theory of fevers, is interpreted a continuation of the other; as if the rigidity or tension impressed on the cutaneous vessels by febrile or an unnatural degree of heat, was merely a continuation of that corrugation which the sense of cold produces on the nerves of the skin. But as I shall treat of this subject in the subsequent part of this work upon the nature of fevers, I shall not pursue it further here. An endless maze of illusions may be conjured up in any science, by transposing causes into effects, and effects into causes; and by explaining phenomena which have their established unvariable causes, such as these actions, whether of the solids or fluids, which depend on
our

our sensations, into incomprehensible actions of some unknown power called *life*, excited in it by some as unintelligible cause.

IT is not easy to trace physically, in such a complex system as ours, where there is every where such a reciprocal action and re-action, and such a concurrence of various circumstances conspiring in the producing and supporting every effect, the precise origin or nature of almost any single phenomenon belonging to our constitution ; but it is always possible to attain so much accuracy in these matters, as to enable us clearly to distinguish the nature of one action from another, and to make such an application of terms to things or actions which can be distinguished from one another, as shall preserve us from running into perplexity and confusion in our ideas of things.

As *irritability* then and *spasms*, are two symptoms that always accompany either hysteric, hypochondriac, or nervous diseases, I shall endeavour, in a few words, without further discussion of the physical causes of either, to establish such a distinction between the one and the other, as may be of some practical use, and serve as a criterion for distinguishing these subtle processes in our frame from each other, at least as diseases.

THE one, namely *irritability*, signifies, or ought to signify, that mobility of our system of solids and fluids taken complexly (for I can in no possible case consider them independent of one another in any one vital or animal function) by which external impressions re-act upon the seat of sensation or perception. *Spasm* is an involuntary impression from the same seat of sensation upon the instruments of voluntary motion, the muscles, and muscular fibres,

fibres, where-ever they are spread ; and it always (excepting in cases of violent irritation) implies the equilibrium lost between the solids and fluids, from a decay of the vigour and animal warmth of the latter.

L I F E.

METAPHYSICALLY, this term signifies that whole system of conscious powers which can be supposed and understood to have an existence independent of matter and mechanism, though we know not how.

PHYSICALLY, *life* signifies that system of materials, mechanism, combinations, and that system of motions, actions, &c. resulting therefrom, which characterises such a system of materials physically alive, that is regular and constant in the performance of a series of natural, vital, and animal functions and operations ; the disorder, weakening, &c.

of which, in whole or in part, constitutes a disease.

IN a mixed sense, that is, in beings composed of a combination of mental and material properties and actions, the term *life* comprehends all that influence which these two parts of our composition have upon each other.

THESE distinctions being properly regarded, will establish a clear and distinct idea to the term *life*, when it is used in physiology; and the neglecting of them must render the meaning of the term full of obscurity. Who can comprehend what our physiologists mean, when they apply the term *life* to a fluid or fibre of our constitution? nay, even to one or other of these, for some time after they are detached from it? I can easily suppose that some of these material motions which belong to physical life, may, for a little space of time, belong to a member or to a moiety of
of

of a fluid, after it is disjoined from its whole, or may retain for a little some of the properties belonging to the animal combinations of its parts; but more than this, it is not possible to comprehend. Though elasticity, irritability, the power of spasmodic contraction, &c. form part of the properties of the animal materials, it does not follow that the term *life* is more properly applicable to these phænomena of bodies in their animal state, than out of it; merely because in their animal state they stand in connexion with other circumstances, which all taken conjunctly, constitute, in whole, *physical life* *.

C H A P.

* I am afraid that a false intemperate ambition for making discoveries, and an irrational affectation of treating even mechanical facts, as not the subjects of reasoning, have contributed largely to the multiplication of mysteries in both Physics and Physiology. It is not enough that we have adopted into physiology, Life, an occult quality which matter acquires in consequence of being assumed into the animal system; but that mys-

C H A P. XVII.

Of the Indications of Cure in Hysterical Disorders.

BEFORE the reader shall have advanced thus far in these discourses, he must have discovered, that it has not been my intention to write a practical treatise

tic principle must have its mystic effects too. We are informed in the last volume of the Philosophical Transactions, that—Life has a power of producing cold—This is such a novelty in physics as few would have dreamed of indeed. But wherein is this peculiar to life? Every body has a power of communicating a moiety of its coolness to any other body hotter than itself, that is brought within the atmosphere of its influence. Why should it not add to the mystery, that every hot body that is cooled by a colder one, is, in return for the coolness it communicates, heated as much as the hotter body is cooled?—Cold water and hot water mixed together, in equal quantities, will make tepid water. If this is a mystic property of living bodies, is it not as much a mystery in dead ones? It brings to my remembrance

treatise on this disease, and to inform the public what course I would take with hysterical patients, or what recipes I would write for them ; far less to pretend to instruct others how they should treat them. My design must discover

membrane a similar retrograde mystery in physics—When a billiard ball is impelled against another at rest, the motion passes out of the moving one into the one that was at rest, and the rest passes from the one that was struck into the one that strikes, and arrests it—In other words, they make a fair exchange of their opposite *vires inertiae*.

I must take the liberty to add here a very obvious inference from the experiments made upon the Heated Room, that have been so much talked of among the curious of late.—The heat which dense and solid bodies, such as stones, metals, &c. acquire in an atmosphere, is no gage for the heat of the atmosphere itself. I fancy few are strangers to this fact—that stones or metals exposed long enough to the rays of a warm sun, in the common air, will become too hot to be handled. This will contribute to explain that puzzling circumstance mentioned by one of the gentlemen who prosecuted these ingenious experiments, who could not in whole, nor even in part, coagulate the white of an egg, except when it was put upon metal.—He may assure himself, it was not the life that was in the albumen that resisted its coagulation.

itself

itself throughout, to have been the proposing some views relative to that disease, relative to the female nature and constitution in particular, and relative to the human constitution in general, which have not been much attended to, or prosecuted ; and which, if just, may be of general use, not only to the physiological, but to the practical improvement of medicine ; especially that branch of it which relates to the management of the female sex, suitably to their importance, and the many accidents and dangers their constitutions are exposed to, which these of men are not.

FROM the different causes, constitutions, periods of life, &c. which contribute to the exciting and irritating of the hysterical disease ; from the difference of its degrees, and the different sources of its symptoms ; it is plain no general uniform plan of treatment can be laid down for it.—At some times, it is to be soothed ; at other times, it ought to be subdued

subdued by evacuation or revulsion ; while other cases require bracers, or tonics.—Some cases require medicine, and others only a proper regimen of the non-naturals.—In some cases, it is requisite to pay a direct attention to the symptoms, according to their urgency ; in other cases, these are to be neglected, and we ought to address ourselves only to the cause.—Sometimes, it is only necessary to attend to the state of the first passages ; at other times, a regard is to be had to the whole habit of the body.—In most cases, the intention of cure ought to be complex.—In all cases, the state of the skin, and an equal distribution of heat over all the surface of the body, with a regular state of the organs of digestion, are always primarily to be regarded.

SOME people, by mistake, apprehending that the disease proceeds always from poverty or imbecility of constitution, think they contribute to their own
cure

cure by such diet as is esteemed most nourishing and restorative ; but in that they are often greatly mistaken ; what is plain and of easy digestion, often contributing incomparably more to the cure ; but in all cases, the quantity of diet is of more consequence than the quality of it. If in this, as in most chronical diseases, people could regulate their diet, so as to be often hungry, and never very full, they might be their own physicians.

ONE thing I must take the liberty to observe ; in very few cases of the hysterical kind, are these hot stimulating medicines, commonly called Uterine, Emenagogue, or Antihysterical, indicated ; and in any case where they are proper, *Assa-fœtida* is sufficient to supply the place of all others ; it being a medicine of great use, not only out of the paroxysms, but during the attacks of them. It is generally improved by being accompanied with laxatives, or
 absorbents,

absorbents, according as either or both are indicated ; one or other of them being almost always requisite during the continuance of hysterical symptoms. Where this disease is complicated with scorbutic acrimony, Gum Guaiac, properly managed, is an excellent medicine, suited to both intentions.

C H A P.

C H A P. XVIII.

Of the Distinction between Hysterical and Nervous, or Hypochondriacal Disorders.

AS nervous and hysterical diseases, though in fact very different, have the appearance of something congenial in them, and a great similitude in many of their symptoms, I think it requisite, before I close this subject, to add some reflexions on the former, to what I have said on the latter.

VAN HELMONT, notwithstanding his singularities, was certainly a very great man, of a penetrating genius, and deep reflexion. It was, no doubt, on account of the remarkable sympathy and intercourse that he observed between the stomach and the head, the seat of both the conscious and unconscious fountain of life, that, in imitation of the allegorical

cal genius of the Ancients, he gave a personality to his *Archeus*, or president of digestion, seated at the upper orifice of the stomach.

THERE certainly is a very notorious reciprocal sympathy between the stomach and the head; and anatomists discover a very rich display of nerves about the upper orifice of the stomach. The uterus only excepted, no part of the human constitution communicates with the head as it does. It alarms the head with its disorders, and in a manner provokes it to its assistance under all its uneasy sensations, pains and oppressions; and this seems to be the obvious reason, why there is such a general similarity between the symptoms of hysterical and hypochondriac or nervous disorders. I call these synonymous, because wherein they may be supposed to be distinguished, the difference is only in degree.

THE stomach is certainly the immediate cause of all these symptoms, commonly called nervous, or hypochondriac. They all derive their source from a weakened viciated digestion; from the undue fermentation, or corruption of the aliments, and of the secretions that should minister to their digestion in the first stage of their passage through the bowels. When this disorder of the stomach gathers strength, and becomes habitual, it necessarily draws all the other parts of the intestines and their connexions into consent with it; and hence these viscera become afflicted with irregular pains, spasms, distensions, flatulencies, &c. in different parts of them. These are generally attended with great irritability of the nervous system, great lowness and inequality of the spirits and temper; fears, uneasy sensations, imaginary diseases, or apprehensions of dangers from their complaints.

So far, or rather a little below this state of the disease, it is commonly called nervous; but if it advances beyond this; if the patient is afflicted with violent heart-burnings, irregularities of the appetite, great costiveness, black bilious vomitings or purgings, involuntary spasms, and twitchings in different parts of the body; or, if superadded to these, he is invaded by faintings, convulsive tremors, frightful and dismal ideas, a delirious imagination, or excessive inequalities of the mind, then the disease is commonly called either the hypochondriac disease, or an atrabilious melancholy.

THE primary remote cause of this disease is either a natural weakness of the intestines, or some disease fixing upon them; rendering them weak, debilitating or viciating the digestive faculty, and the secretions belonging to it; by which means, the solids, losing their equilibrium with the fluids, become

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more and more overcharged, and in some measure oppressed by them. In this case, the symptoms of the disease rarely ascend beyond the standard of what are commonly called nervous complaints.

IF the disease is not owing directly to the preceding cause, then it must be referred to a difficulty in the circulation of the blood through the liver, by its being either obstructed or weakened; or else from too great a viscidty or other disorder in the blood, retarding its free passage through the liver. In any of these cases, all the digestive bowels become oppressed in their natural powers and functions: for the blood, in its return to the heart, passes from the intestines into the liver; and they must become loaded and disabled for their different offices, if the liver, which receives the blood from them, passes it with difficulty, from whatever cause.

THE secondary remote cause of all these symptoms must be referred to some suppressed evacuation, particularly of blood itself; such as the want of a constitutional, hemorrhoidal, or menstrual discharge, or a suppression of any habitual bleeding at the nose, &c. or else, which is too frequently the case, it must be referred to some species of latent acrimony in the blood (commonly called the Scurvy, of whatever kind it is) which has either been injudiciously repressed, or which Nature cannot muster forces sufficient to expel by some critical discharge.

FROM this detail of the disease, even a person of moderate judgement in physic, may make the two following instructing inferences. 1st, That there can be no perfect cure of this disease, without striking at the ultimate and most remote causes of it, and remedying them; which must be a work of time. 2dly, That the more early the

disease is attended to, before it has taken too deep root in the constitution, the greater hope there is not only of curing it, but of curing it sooner than can be done after it has sapped the constitution by the ravages its various symptoms have made in it.

IN the advanced stages of this disease, it is impossible to put persons subjected to it upon a safe plan of self-management, or to lay down rules for piloting themselves through the perplexities both of body and mind which it occasions. But in these lower degrees of it, which are so common to both sexes, it would be easy for them, if they had the command of their own inclinations, to annihilate the disease by a proper attention to, and management of themselves.

As this form or degree of the disease prevails principally among younger persons, a little medicine, and an exact management of themselves, are all that is necessary.

necessary. It frequently happens that the temporary curing of such complaints by medicine only, (which may be done), if no attention is paid to the management of diet, pleasures and exercise, either at the time or afterwards, terminates only in the return of the disease soon after, with greater violence and obstinacy. When persons find themselves suddenly, easily, or unexpectedly relieved, they are tempted to plunge themselves again into an irregular course of living, so that in a short time, they find it had been better that they had not thought themselves so completely cured.

HOT medicines never agree with young constitutions; they tend to encrease the fire natural to their age, which should be abated rather than fed; even the Bark, which is the coolest of almost any strengthening medicine, is too much for them, without being tempered by laxatives, absorbents and neutrals. A tea of the Bark, of Camo-

mile Flowers, Gentian, or Centaury, or of all these mixed together, taken twice in the day, with half a drachm of Magnesia*, or a drachm of Soluble Tartar, or of Vitriolated Tartar, will have a happy effect on a young constitution in very bad repair, if moderation is observed both as to the quality and quantity of what is ate and drunk ; *where* as vinous or spirituous infusions of hot stomachics, aromatics, and other irritat-

* This for some time has been a fashionable medicine, merely because it is the absorbent we have become most lately acquainted with ; therefore various attempts have been made to spoil it, by an affectation of peculiar nicety in the preparation of it. It will not purge at all (notwithstanding what has been said to the contrary) if either by excess of washing, burning, &c. the neutral salts are wholly separated from it. I have known it prove violently binding by this method, and consequently become hurtful to both old and young. Too much of it also (even though not so spoiled) is not good for infants of very weak habits, who cannot bear an excess of neutral salts : it cools their blood too much ; therefore, when continuance in the use of it for some time becomes requisite, it should always be properly qualified.

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ing nervous medicines, would enrage instead of alleviating every symptom of the disease.

BUT to prevent mistakes, which too frequently happens, in deciding upon the complaints of young people, especially males, let it always be remembered, that an overfullness of habit will often produce individually the same symptoms that are too generally and uniformly attributed to weakness, relaxation, debility of the nervous system, and coldness of the constitution. Similar symptoms are often excited by opposite causes, and an error of judgement in such cases is an unhappy accident for the patient.

1891

Received of the Treasurer of the
Board of Education the sum of \$100.00
for the year 1891

Witness my hand and seal this 1st day of January 1891

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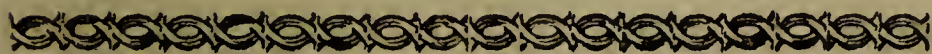


S U B S T A N C E

O F A

L E C T U R E

Delivered at NEWCASTLE, 28th DECEMBER,
1773, on the NATURAL POWERS
employed in the CIRCULATION of
the BLOOD, independent of the AC-
TION of the HEART.



—— I NEED scarcely do more than mention to you, that a muscle is a composition of animal fibres which have a power of contracting and consequently of moving themselves, and whatever is connected with them ; and that the heart is such a muscle, or rather collection of muscles.—The arteries are these vessels that carry the blood from the heart to all the parts of the body, dividing constantly off from one another, like the branches of a tree, till they terminate in the greatest conceivable tenuity.—The veins which bring the humours back again from every part of the body, begin in the same attenuated state as the arteries ended in ; and as they unite, they enlarge, till they meet in one great trunk or vein, which brings the blood back to the heart again.—The heart itself consists of four chambers, or rather of two pair of chambers, each pair consisting of an outer and inner one.—Each of these chambers is to be considered

dered as a distinct muscle, or muscular bag, which has a power of contracting itself separately.—Into the outer chamber of the right side, or more properly the fore side, of the heart, the great vein I mentioned, called the Vena Cava, opens and pours in the blood. When that outer chamber, commonly called the right auricle, is full, it contracts by its muscular force and empties itself into the inner chamber, called the right ventricle ; which, when it is filled, also contracts and injects its contents into an artery called the pulmonary artery, which by its divisions and attenuations sheds the blood through the whole substance of the lungs.

IN the second pair of chambers of the heart, the like process is transacted over again. The incipient and imbibing veins take in all the blood diffused through the lungs by the arteries, and uniting their forces as they meet, terminate all at last in one great vein,
called

called the pulmonary vein, which unloads itself into the outer chamber of the second pair of rooms, called the left auricle of the heart, which, when filled, contracts and issues its contents into the inner chamber, called the left ventricle of the heart, which when it is full, contracts also, and discharges itself into the great artery, called the Aorta ; which branching off, and separating into infinite subdivisions, both in regard to their number and tenuity, diffuse the blood in form or in substance to every organ and spot in the animal system.—I need only observe further to you, in order to your distinctly conceiving the actions of the heart above specified, that, each chamber is furnished with a complete set of valves, which, when the chambers contract themselves, exactly shut and preclude any of the blood from being forced back again by the way that it entered.

FROM

FROM this historical account of the perpetual transactions of the heart, you must distinctly perceive, that in the subsequent discourse I do not pretend to disprove that it is by the action and force of the contractions of the heart that the blood is thrown out of it into the arteries : But I propose to demonstrate, that these actions have little or no concern in supporting the progress of the blood along the finer arteries, after it is thrown into the great ones, and still less, in having any sensible influence on its motion through the veins back again to the heart.

THE circulation of the blood, as above-described, was no sooner ascertained by the celebrated and learned Dr. Harvey, than the force and energy of the muscular contractions of the heart was first universally supposed, and then admitted and acquiesced in almost implicitly, as the only considerable moving cause of the whole : And this, with few variations

variations or additions, continues to constitute the sum of the doctrine of the circulation, from the æra of Dr. Harvey down to the present time.—The nature of this discourse does not require that I should enter into any particular detail of all that has been suggested or said upon the powers of circulation. I shall take notice of such particulars as I know, or as occur to me, in the course of this discourse. If any other author before me, that I may either have not seen, or not attended to, has advanced what I may imagine peculiar to my sentiments and reasoning in this disquisition, I can content myself with the originality of my own reflections, without contending for the honour of priority with such persons *.

* Since this discourse was delivered to the printer (Jan. 1774.) I have seen in a list of foreign publications, a treatise in Italian expressly upon the same subject, published at Modena.

By the vigorous contraction of the heart, and the elastic or muscular reaction of the throbbing arteries, then, together with that species of lateral resistance, from the atmosphere without us, and what acts as an equivalent to it within us, (without which indeed all motion would languish and fail) the blood is supposed to be urged on to the finest filaments of the arteries and glands ; and not only so, but to be propelled into the incipient veins, which, uniting their streams, unite also their forces in bringing the blood back to the heart again.—As a supplement to these powers, the late ingenious and learned Dr. Whytt suggested, with some reason, the perpetual oscillations of the finer vessels, squeezing the blood forward in the direction of its progress † :—to the assistance

† That there is a perpetual motion of the animal fibres everywhere, while natural heat remains in the body,

assistance of the motion of the venous streams of blood in the primary filaments of the veins, the attraction of capillary tubes, by which liquors are disposed to rise in them to certain heights, is suggested as necessary, and also the motion of the muscles everywhere when they act, pressing the vessels.

THE first supposition I shall speak to by and by—but that last is so incidental, and the progress of the circulation is in so many instances equally persisting when every muscle is at rest, that little weight can be allowed to that as a necessary and permanent cause.

body, somewhat analogous to the vermicular motion of the intestines, is pretty certain. It would seem to be maintained principally, by the constant relapse, wandering, and re-absorption of warm active effluvia everywhere; and by the perpetual action of the nerves or ultimate fibres, as after explained, everywhere.

BUT

BUT notwithstanding all the auxiliary supplements that may have been occasionally suggested, as conspiring in support of the circulation, still the force and momentum given to the motion of the blood by the muscular contractions of the heart, has been esteemed of such importance, and so sufficient for the weight of the charge, that the most celebrated calculators, such as Borelli, Sir I. Newton, Keil, Jurin, Hales, Haller, &c. have engaged in the nicest experiments and calculations to ascertain with precision, the force of the muscular contractions of the heart,—the quantity of the blood thrown into the arteries by each systole,—the force and velocity with which the blood is propelled into the arteries, &c.

INDEED the fact of the heart's contractions, and the expulsion of the blood out of its cavities thereby, is so certain, and the supposition of its power for accomplishing all that is inferred from

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it,

it, has the appearance of being so simple, so mechanical, and so natural, that it is no great wonder the subject has hitherto escaped a stricter and more accurate examination.—What escapes the most penetrating geniuses, may sometimes be stumbled upon by very ordinary capacities; which ought to be considered as an encouragement to every man's industry, let his genius be ever so ordinary.

THE intention of this short disquisition, then, is to prove, that the force impressed upon the blood by the heart, is not the power which conveys it to the extreme vessels, makes it penetrate every pore and filament of our frame, and from these subtile transfusions collects it, and returns again, what does return of it, to the heart. This I shall endeavour to do by a demonstration of the following propositions; 1. The heart is not the fountain or origin of the motion of the animal fluids. 2. The
blood

blood in passing through the heart, and being subjected to its impressions, acquires no quantity of motion that it was not possessed of before. 3. That the arterial motion of the fluids does not depend necessarily on the impulses of the heart, but can be accomplished independent of any such force. 4. The mechanical force or momentum of the heart's contractions is absolutely insufficient to propel the blood to the extent of the arterial circulations and secretions. 5. There are, in fact, other powerful agents always subsisting in the animal frame, which, by a mechanical necessity, must act in promoting the progressive motion of the blood, more immediately than the heart can do, and where the powers of the heart cannot reach. 6. There are, besides all these, influences presiding in the animal system which can be reduced to no mechanical standard, but, at the same time, without which all the intricate mechanism in our frame, just and unerring as

it is, would not be sufficient to support one revolution, nay, nor one moment's progression of our fluids. To these, by way of corollary, I shall add, 7. That both the primal and final intention of the agency of the heart in the animal œconomy, must be some further purpose, very different from, and less obvious than, the supporting of the progressive motion of the blood.

FIRST PROPOSITION.

FIRST then, I say, that the heart is neither the original seat of the motion of the animal fluids, nor the original cause of their motion. It is self-evident, I apprehend, that we must look for the primary cause and powers of the motion of our fluids in the organs, which are constantly employed in taking in that stock of fresh supplies, which the repairs of our constitution, and the support of its motions require; and here we are necessarily referred to the absorption of the chyle, or of our digested

gested aliment. The pulsations of the heart, or the momentum of its contractions, cannot reach the chyle in the first passages, and force it into the lacteal vessels: these vessels, as absorbents, having not the least communication with arteries, can partake of no assistance from them, in taking up the chyle, and transmitting it to the blood. Now the lacteals are a venous system of vessels, and the chyle's motion in them is entirely venous; that is, it is a concurrent motion, where the vessels and the streams that flow in them, are always uniting and enlarging*. How much it is the characteristic of all venous

* Some may imagine, that the discharge of the chyle by the lacteal duct into the left subclavian vein, is of small consequence in estimating the powers which move the fluids; but this is a great mistake: for, as in a sound habit the repairs of nourishment must be equal to the waste, so the power with which these repairs are introduced into the blood must be equal to the circulating powers concerned in the discharges of perspiration, urine, and the animalire parts of the feces taken conjunctly.

systems of vessels to act as absorbents, we shall proceed to consider.

2. In the lymphatics. The discovery of the source of the lymphatic streams, has been of late thought a matter of so much consequence in physiology, as to have been very keenly disputed between two eminent anatomists: so that we may venture to take it upon the evidence of their experiments, that the lymphatics are also a system of absorbent vessels gathering up extravasated fluids, wandering out of the reach of the heart and arteries, among the interstices of the vessels. These then, namely, the lacteals and lymphatics, are two streams in the animal system, that are not only perpetually flowing, but also perpetually supporting the motion of the other vascular fluids, independent of the direct impressions of the heart.

3. THE absorption of the lymphatics appears to me so inconsiderable, when compared

compared with that of the proper veins every where in our system, that, if the lymphatics are not destined for a particular species of absorption, which I am inclined to suppose, I can consider them as no more than provisional auxiliaries to the veins in that office.

4. THE nature of the connexion and of the communication of fluids between the unborn infant and the mother, demonstrates that the supply of a venous circulation by suction or absorption, seems to be universally Nature's direct method of communicating vital supplies, and of supporting the internal motion of the fluids of all organical beings, whether vegetable or animal.

WHEN we maturely consider the immense power of absorption in the skin, and not of it only, but of every surface within the body, one would be tempted to infer, that the veins almost wholly terminated in absorbents.

BUT there is still greater reason for the presumption, if we reflect also that a very large proportion of the animal fluids are always in an extravasated state. If we consider that the immensely largest proportion of the vascular system is of that attenuated kind, which the finest injections cannot reach; and at the same time, if we attend that the exterior surfaces of all these vessels are constantly in as moist and succulent a state as their cavities, we will see strong reasons to suspect, that, though some of the arteries may pass into continuous veins, yet the greater part must be terminated in imbibing orifices, and consequently that the circulation must, in strict propriety, be carried on by the medium of extravasation and reabsorption, incomparably more than by any uniform continuation of arteries into veins.

It is not my intention in this discourse to enter minutely into an investigation

tigation of the physical cause of absorption ; but in so far as it appears of such importance in maintaining the circulation of the blood, I must bestow a reflection or two upon it.

FIRST, then, it is generally, for explication, referred to that power by which fluids are said to ascend in capillary tubes. That the power exerted in every kind of attraction or suction may be the same with that which causes liquors to rise in capillary tubes, I make no doubt ; but still, as the two motions are very dissimilar in leading circumstances, the ascent of liquors in capillary tubes, as illustrated by common experiments, is a very unsatisfactory illustration of venous suction : for, in the first case, the tubes must be in an empty state when fluids are exhibited to rise into them.—Again, fluids do not continue to rise in capillary tubes, but become stagnant at certain heights.

IN

IN venous absorption, on the contrary, the fluids continue ascending and penetrating into vessels that are full, and likewise, they continue advancing progressively, without stagnating or becoming arrested in their motion, at any height or distance from the *origin* ~~prison~~ of the imbibing vessels.

HENCE, secondly, we must infer, that though all the vessels in the animal composition are full from one end to the other, yet there must be a waste or vacuum constantly going on at one extremity of the vessels, in order to give place and make room for what is imbibed by their opposite extremities.—Liquors must cease to rise in any vessel or vessels which are full without waste.—Therefore upon this subject it must, I think, be concluded, that the constant waste and inanitions happening in the animal frame are the direct, though in another sense, the remote cause of its capacity

capacity for constantly assuming fresh supplies into the vessels.

WHAT these powers are, which dissipate the materials of our constitution, I shall have occasion to consider more particularly by and by ; but whatever they are, we must view that power of attraction which brings the chyle into vascular motion, in an inseparable connection with them.

By surveying the actions of our frame in this point of view, you must perceive, Gentlemen, that the venous and arterial circulations become indispensibly tied together, and united in their reciprocal influence upon each other's motions, so as the one must always necessarily imply the other,

I MAKE this observation here, because it may be objected, that though a venous or confluent circulation may not require the impressions of the heart to
per-

perpetuate it, yet an arterial or dividing circulation necessarily does—But I say, that if an arterial circulation can be considered as necessarily instrumental in the production of a venous circulation, which has no dependence on the impulses of the heart; then the power of the heart, which in our constitutions lies between these two extremes, cannot be supposed essentially necessary to an arterial circulation, whose influence reaches to a circulation where the heart, as a muscle, is not at all concerned.

HENCE it is inferred *a priori*, that of whatever importance the modification of the circulation at the heart may be in the construction of animals, yet the heart cannot be said to be essentially and absolutely necessary to the circulation of our fluids.

SECOND

SECOND PROPOSITION.

THE second proposition I have undertaken to demonstrate is, that the blood, in being subjected to the contractions of the ventricles of the heart, acquires no quantity of motion that it was not possessed of before in the veins.

THE heart does not act upon the blood as a pump does upon stagnant water, putting it into a motion and course which it had not before.—This simile is not a correct one; for in fact the principal, though least observed action of the heart, is its power as an exhauster, which I shall also consider: what at present I allude to, is its positive force in throwing the blood into the arteries.—In this respect, I say, it is not like a pump acting on standing water.

IN fact, the blood was possessed of as much motion in the veins when it
arrived

arrived at the heart, as the heart communicates to it in discharging it into the arteries. So that the interposition of the heart's agency in giving motion to the blood, cannot be supposed absolutely necessary to its progress in the arteries, unless it could be proved that the momentum, with which the blood is discharged from the vena cava, was insufficient to preserve its course in the arteries, without the additional assistance of the heart's contractions.---But it is absurd to suppose this, if it can be proved, that the momentum of the blood in the vena cava is as great as the momentum of the blood thrown into the aorta by the heart.

THE heart transmits, by its contractions, no blood into the arteries but what it receives from the veins * ; therefore

* It is true, that the excretions must be deducted from the quantity that the veins receive from the arteries, but that is compensated for by the supplies the veins receive from the chyle.

it cannot deliver it either faster or with greater momentum than it receives it.—Therefore, also, the momentum of the blood in the veins is equally sufficient, as the contractions of the ventricles of the heart, to support the motion of the blood in the arteries.

NAY more, I say, that the absolute momentum of the blood moving in the vena cava, and consequently in all the veins, is greater than the momentum with which it moves in the aorta, and consequently in all the arteries:—For though the heart can deliver no blood to the arteries, but what it receives from the veins, yet the veins really receive as much resistance to the freedom of the motion of the blood in them, by every contraction of the auricles of the heart, as the arterial blood receives accession of momentum by the contractions of the ventricles ; excepting in so far as the muscular vigour of the auricles and ventricles may differ from each other.

I KNOW

I KNOW that appearances may be pleaded against me, and that it may be alleged that an artery of the same dimensions bleeds with much greater violence than a vein does. But in the first place, it may be replied, that there is no making a comparative estimate between arteries and veins in this respect, on account of the different thickness of their coats—on account of the uncertainty of the contiguous anastomoses—and likewise on account of the different state of the elastic vapour of the blood in arteries and in veins.

AGAIN, all circumstances supposed equal, and allowing the fact to be true, the velocity with which a fluid flows out of an orifice is no proof of its degree of velocity in its vessels, but is rather a proof of its progressive motion not being proportioned in velocity to the power with which it is urged. There is a great difference between being pressed with greater force, especially alternately

alternately in the percussive manner, and moving progressively with greater momentum. The first I allow in the case of the arterial blood ; but the last, I deny : at least I am not acquainted with any proof of the contrary.

THIRD PROPOSITION.

HAVING proved under the last proposition, that the motions of the heart add nothing to the momentum of the circulation—that the force of the blood issuing out of the veins is as sufficient as the force of the heart to support an arterial circulation—and that the venous and arterial circulations are connected together, in the relation of cause and effect, by links that are independent on the power of the heart's systoles ; I come now to prove the truth of the same doctrine by examples, that arterial motions of fluids can be supported, and

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are in fact, constantly ^{circulated} celebrated without the necessity of the heart's actions, or the interposition of such a forcer in the center between a venous and an arterial circulation.

BECAUSE in the particular disposition of our frame, the heart is known to occupy this station, and to preside at the orifices of the great arteries, therefore, by I know not what diversion of our attention, or deception from appearances, it has always been taken for granted, that there was a mechanical necessity for the action of the heart there, and that without it, the momentum of the blood in the vena cava could not have been sufficient to have distributed and divided it in the arteries, through such an infinite number of ramifications, and in such an inconceivable variety of directions, produced by the angles, flexures, and involutions of the vessels, as they divide and decrease.

THOUGH

THOUGH perhaps all motion, strictly speaking, is both impressed and continued by pressure*; yet there are certain motions, such as the running of water, the ascent of vapour and the like, that having no sensible appearance of any resistance to their tendency, may in an improper and vulgar sense be termed spontaneous; and such I take the motion of the fluids both in the veins and in the arteries to be.

THE first example I shall adduce of this kind of arterial motion, which is supported without any such impulses as are analagous to the shocks of the heart upon the blood, is the circulation or progressive motion of the sap in vege-

* Though attraction is a term that may be alledged not to define the nature of the power it expresses, but only to denominate the fact, yet as the signification of the word certainly conveys an idea very different from any kind of mechanical impulse, it is to be wished a word for that phenomenon had been adopted which would have given no bias to the ideas of enquirers.

tables. In them, the fluids ascend of their own accord, as we express it, to the remotest branches, leaves, and fruit of the loftiest trees *.

It implies no objection to my argument to allege, that in plants the case is not parallel, as in their transfusion of fluids there is no direct or regular transition of arteries into veins. But what then? still the example is conclusive for what it is adduced to prove; namely, that in their system of circulation, the veins or roots of the plant act by absorption only; and, without the assistance of any vegetable mechanism analogous to the functions of the heart, transfuse their juices to the finest and remotest fibres

* It is certain, that in the vegetation of some trees, fluids rise higher than either what we know of the suction of capillary tubes, or of the pressure of the atmosphere on fluids in vacuo, will carry them; therefore, it is a question, whether there may not be still resources for mechanics to raise fluids higher than it is at present supposed fluids can be elevated by artifice.

of the plant, which are its system of arteries.

AGAIN, to come directly to the point, we have in the particular œconomy of the liver a proof of that very species of circulation in our system, without the intervention of any pulsatory action, which has been supposed necessary to give venous blood an arterial direction and momentum.

THOUGH the liver is the most massy and compactly-formed viscus in the whole animal composition, yet the venous blood gathered from all the internal parts of the lower abdomen, entering it, immediately changes its confluent course.—The end of the vein entering a particular part of the liver, (called by anatomists, the portæ or gates) resolves itself into an artery, divides into branches, and spreads its ramifications through the whole substance of the liver, where, after furnishing the secretion of the bile,

the blood has a second time its course reversed into a venous one, re-collecting it from the extremities of this singular artery, and bringing it back to the general conflux of the blood in the vena cava before it reaches the heart.

IN this institution of animal circulation in the liver, the heart can have no immediate concern more than the kidneys, or any other particular organ in the constitution. Therefore we justly conclude that the heart occupies its station not as a *sine qua non*, or indispensable organ in the circulating of animal fluids.

NAY more ; in the regulation of the circulation in the foetus, or in unborn infants, the Author of Nature has shewed us, that at the heart itself, Nature, the minister of his power, can manage the circulation even there in a great measure, without the heart's assistance.

FOR, least the lungs of infants, upon their first coming into the world, should be either so over-grown, or so over-charged with blood as to resist the impressions of the first breath of life rushing into them by inspiration, the better half of the blood discharged in born persons into the heart by the vena cava, is in unborn infants conveyed by a canal provided for the purpose, straight into the aorta or great artery, without being subjected to the impressions of the heart at all. So that this moiety proceeds in its course along the aorta, &c. without the assistance of the heart's action.—Nor can it be supposed that this moiety of blood owes its after progress in its arterial course, to the strokes of the heart on the other moiety that passes through the lungs; the heart's power being only sufficient for the quantity it acts upon.

FOURTH PROPOSITION.

THE fourth proposition which I shall endeavour to prove, is, that the muscular power of the heart is not of force sufficient to impress that momentum upon the fluids that must be required to carry them to the ultimate limits of the circulation.—I never addicted myself much to these branches of physiology, which depend upon nice algebraical calculations, therefore I will rest my conclusions here upon such general principles as will sufficiently answer my purpose.—For the argument's sake then, I shall in the first place, admit that the muscular force of the heart is as great as any person upon calculation has supposed it to amount to. —————

IF the progress of the circulation in the arteries depended upon the mechanical force with which the heart threw the blood into them, may it not be asked, What then is the reason that
no

no fyringe can be invented that can be made to drive the subtilest and most searching liquor half so far, or into one tenth of the number (I take a definite for an indefinite here) of the vessels that the heart reaches and fills by its injections?—If it is replied, that this is owing to the different circumstances that both solids and fluids are in, while subjected to the impressions of the heart's power, from these the dead subject is under, when artificially injected ; I grant that it not only may be so, but that it certainly is so:—But then, it also certainly follows, that these circumstances, and not the heart's force only, are the cause of the success of its injections reaching the finest and remotest filaments and excretories in the animal system.

THERE are powers in Nature, which can insinuate and drive moisture, both into vessels and into the interstices of bodies, so as to overcome an inconceivable

ceivable resistance to its progress.—By such means, the hardest twisted ropes may be shortened with such power as to move immense weights fastened to them; —and the roots of trees have been known to open fissures in very massy rocks which resisted their growth and distension.—But in such cases, any power driving such fluids, analogous to the contractions of the heart in the animal system, would prove of as little effect almost in the promoting of such motion, as the fannings of a fly's wings would.—The case is nearly similar in regard to an infinite number of the compact filaments and strainers through which the animal fluids have to make their way.

AGAIN, if we consider the nature of the fluid, I mean the blood, supposed to be so syringed by muscular force, through such a complicated series of meanders and involutions in the slenderest and almost invisible vessels, we shall

shall find it the unfittest liquor that can be imagined to be driven in its course by main force:—for it must be a force not only sufficient to urge a permeable liquor (which yet is impossible) but it must be a force sufficient to grind down the viscid, glutinous tenacity of the blood, and break down the unequal sizes of the particles of its constituent parts.—That all this can be done by the main force of the contractions of the heart is so impossible, and so palpably so, that it never could have been thought of, but through the greatest inattention.

If it is alleged, that the momentum of the heart is not supposed to be concerned in attenuating the blood, and changing it into the subtilty requisite for passing the finest canals and emunctories in its course,—I shall accept of the concession, without making any strict enquiry, whether many physiologists by their mode of reasoning and explaining themselves, have given sufficient cause
for

for the imputation or not.—But if it is allowed, that it is not the momentum given to the blood by the heart that resolves it in the course of the circulation ; then it follows, that there must be some other active power in our frame, which can change the structure and tenacity of our fluids at will. This implies, that that power which changes the blood, when the force of the heart cannot do it, must also be the power which moves the fluids, where they are so changed by it.—For where they must be changed, there they must have stuck if they had not been changed.

IN short, every consideration conspires to evince, that the power of moving the fluids, where they are changed or assimilated to the nature of the parts they arrive at, and the power that assimilates them, must be one and the same ; —and what moves by that principle, must move spontaneously, that is, without any occasion for the application or assistance

assistance of that power we apply the idea of downright mechanical force to.

THERE does not appear to be in our constitution any of these strainings and filtrations, that have often been supposed in physiology. Our fluids are digested in such a wonderful manner, and at the same time, the various organs are so wonderfully adapted to them, that whenever they arrive within the influence of each other, the fluids instantaneously resolve, or are metamorphosed, and disposed into a motion conformed to the structure of the organ.—They move, to use the simile, as iron does when it is said to be attracted by the loadstone.

I BEG leave to touch upon another consideration relative to this proposition, before I dismiss it. It is another mistake of inattention, and not a small one in my opinion, which physiological calculators have stumbled upon in their computations. They have always supposed

posed that the heart contracts with the utmost muscular force it is capable of exerting ; than which, in my opinion, there cannot be a greater mistake.

No muscle can be either always, or the half of always in the exertion of its utmost muscular vigour and power.—This, in a very short time, would upset the whole equilibrium of our system. The strength of a man's muscles may be able, by way of essay, to lift and support for some time, by their utmost tension, an hundred, or we shall suppose two hundred weight. But if all his life was bestowed in such an exertion, it would become a very short one.—Reaction will always be equal to action ; and this law infallibly holds true in our system, as well as in all other cases. Every violent action has a violent effect, which must affect the whole constitution.—The energy of the smallest muscle exerted every moment, or every other moment, would throw all our other animal functions

functions out of that poise which is essential to life.—A muscle acting perpetually or momentarily at the utmost stretch of its force, would become to the constitution like the power of the spring or weight in a piece of clock work, without a regulator or pendulum.

I AM not ignorant that muscles without antagonists are said to be always in a state of contraction, without any of that hazard I apprehend. But no natural involuntary contraction is ever violent or extreme.—The contractions of such muscles are a state of ease and not of force; it is a gentle play, and not a violent labour; and such must the action of the heart be—Therefore the blood cannot require these violent efforts to force it into its course. It must go almost spontaneously, as a ball thrown gently down hill, or that is humoured, so to phrase it, in its tendency.

IN fact, I think there is much reason to presume, that almost all the quantity of motion the blood actually receives from the heart, is exhausted in the extension of the vibrating arteries—The rest of its progressive motion we shall, as we have hitherto done, call spontaneous, until we can discover what other powers existing in the system, preside over and regulate its course; which brings me to the

FIFTH PROPOSITION,

WHICH I propose to confirm; that, namely, there are other powerful agents always acting in the animal frame, which by a mechanical necessity influence the progressive motion of the blood, as well where the powers of the heart can be traced, as where they cannot possibly reach. All arterial circulation terminates either in evacuation—transfusion—or accretion.

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As accretion cannot be supposed to be performed by the action of the heart upon the fluids, but by that power which disposes similar substances to coalesce, whenever the quantity of that tendency is greater between them than the tendency of such particles to separate motion; there is no occasion for being more particular on this article.—We shall therefore proceed to consider evacuation,——Transfusion depending upon it.

THE evacuations of the circulating fluids, then, are performed either without the body, that is from the surface of the body, to which the common air has access; or—within the surface of the body. The last, namely, the evacuations within the surface of the body, are—either drained off by glandular secretion, or—by accidental escape of humidity into all the interstices and exterior surfaces of every vessel and fibre.

THESE then I would have you to consider, Gentlemen, as the leading circumstances, which not only give direction to the motion of the fluids, but which actively solicit them in their course, as I shall afterwards shew more particularly.

LET us next consider what are these requisites in the fluids themselves, which dispose them to what I shall be well enough understood in calling *self-motion*. —The first requisite then is, that a fluid be endowed with an evaporable degree of heat: Such a degree as disposes it to press towards a colder place and state, and to fly off in vapour where-ever it can escape or get vent. This quality the blood is possessed of in a very remarkable degree. It discovers more vapour or volatile effluvia in it, than any liquor of the same degree of tenacious viscosity that we know would do, under an equal degree of heat.

THE *second* requisite is, such a mixture and composition of principles in the fluid, as disposes it to that peculiar kind of intestine motion, called *fermentation*, by which the liquor expands itself, runs into new combinations, and generates new principles.—Thus, by fermentation, spirituous liquors are generated out of saccharine ones, and acids are generated out of spirituous liquors, or such as might become so: And out of animal liquors, allowed to run into the same kind of intestine motion, are generated foetid and volatile spirits.—Now there is a double tendency of this fermentable kind always existing in the blood; the vegetable part of our chyle or concocted food is, by this intestine process, always assimilating into the animal nature, and the animalized parts of our fluids are so disposed to that fermentation which terminates in putrefaction, that nothing could preserve them from it, but the directing of its

nifus from that tendency, into a progressive motion.

THE *third* active principle in liquors disposing them to self-motion is, the tendency in all liquors disposed to ferment, to generate and extricate very volatile elastic effluvia of particular kinds, now commonly, though perhaps improperly, called *fixed air* : and this, most probably, is one cause of the remarkable abundance of elastic vapour, which I observed already was so copious in the blood.

WHENEVER vents are opened to liquors strongly disposed to self-motion, by any or all of the above circumstances, thither its whole nifus must be intended. A familiar and striking instance of this we have in liquors put into bottles, and corked before their fermentation is finished. We all know with what violence they will not only discharge the corks out of the bottles, but

but throw themselves out of them in *jet d'eaus*.

IT is one of the manifold strokes of infinite penetration and sagacity, discovered in the regulation of our fabric, that the innate disposition in our fluids, arising from their commixture, to degenerate from their animal state, should continue so long to be exactly so far, and no further exerted, than to determine them by its nîsus into progressive motion ; and that, at the same time, this very progressive motion should prove that very critical check which restrains the nîsus to putrefaction in animal fluids, from advancing any further towards a pernicious change.

THE first series of passages, above-mentioned, prepared for the progressive course of the blood disposed for motion, as just now described, are the pores of the skin ; which are of three kinds:——

The terminations of arteries—the excre-

tories of these glands immediately under the skin, commonly called the sebaceous glands—and the accidental, we may call them, vents, through the intertexture and agglutination of the vessels of the skin, which give passage to such portions of the extravasated effluvia as approach these orifices.

ALL liquors which, from their attenuation, warmth, and divided state, are evaporable, have a tendency to fly off into a cooler and less confined region, and to recede from that degree of warmth which volatilises them, whenever they can. This course they take wherever the air has access to them, as on the surface of the body, the lungs, &c. —Upon the same principle, the particles next in succession to these that have escaped, take their place, and those immediately behind them again occupy theirs: And so the same principle has its influence backward to the very rise and source, not of the arterial circulation

tion only, but to the remotest venous absorption also.

THIS, I apprehend, is nearly what is performed in vegetable circulation; and this power, in common with vegetables, we have constantly exerting itself in promoting our circulation.—But though we have this power in a degree as much more active in us as our fluids are warmer and more evaporable than theirs, yet it is far from what is sufficient to accomplish all the intricacies in the motions and secretions of the animal fluids.

THOUGH it may be questioned whether there is in the compass of nature such a thing as a strict and proper vacuum, yet we certainly find everywhere such improper vacua as answer all the purposes of absolute ones, by not only giving free access to the motion of grosser and more consistent bodies in them, but by really giving the motion of all

such bodies a direction and tendency towards them.—Whatever is the mechanical cause of this, I have no occasion to enquire into it just now: It is sufficient for my purpose at present, that this matter may be depended on as a fact.—Where-ever then there is the secretory or excretory duct of a gland, there, or in the course of the liquor secreted from that gland, there is to be found such a vacuum as necessarily influences the course of the humours arriving at it: it does so as necessarily, as a cupping glass either swells the part, or draws the blood into it, where it is applied.

LET us illustrate this by an example where this influence is most obvious. In each of the kidneys there is a cavity, called the pelvis, into which all the secretory vessels of these glands open: Of course, when that cavity is empty, thither will the liquor in the secreting vessels flow, and thither will all the liquors in the vessels communicating with
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the secretories strain their motion and tend.—If these cavities, called the pelves, had no vent from them, whenever they were full, the tendency of more liquor into them would be at an end, and the circulation in the kidney would stop of course ; except in so far as the regurgitation might be relieved by absorbent veins.—But there is a long canal opens into the pelvis of each kidney, and runs from that down into the bladder. By emptying the bladder, there is a comparative vacuum made, equivalent to the size and quantity of the urine it contained before it was emptied.—I call it a comparative vacuum, because the room of the full bladder, when emptied, is occupied only by the elastic effluvia contained in the intestines pressing the lower abdominal parts into the vacuum made by the discharge of the urine. So of course, the bladder becomes as necessary and effectual a drain from the pelves, or cavities of the kidneys,

kidnies, as these are to the kidnies themselves.

THE case is precisely the same, though perhaps not so obviously so, with regard to every gland in the body—each has its secretory either more immediately or more remotely sucked by the influence of some one comparative vacuum or another.—I say, sucked, not because of the physical propriety of the term, but because it emphatically expresses the agency that I would have you conceive these vacua have upon the fluids contained in vessels that they correspond with,

By what means of the same kind there is carried on a constant extravasation of effluvia, which bedews and keeps plump and succulent all the parts of the body, exterior to the vessels and fibres every-where, will be best understood by explaining the important vacua, by which

which the venous flux of the blood is immediately affected and preserved.

EVER since the ascertaining of the circulation of the blood, that is, for above these hundred years past, physicians have treated the momentum of the heart's contractions throwing the blood into the arteries, as a subject of the greatest attention and importance both in physiology and in the practice of medicine.—But none, that I know of, has bestowed that attention which is due to the essential part the heart acts in the promoting of the venous circulation, not by its impulses, but by its depletions: yet nothing can be more absurd than to suppose the one, or more inattentive than to neglect the other.—The sole support and preservation of a venous current of blood to the heart, depends upon a vacuum being momentarily provided where the veins shall unload themselves,

I HAVE shewn already, in the mode of circulation instituted at the liver, that the impelling pulsations of the heart are not of essential necessity either to its arterial or its venous circulation. But in the mode of circulation established at the heart, its evacuations, or its alternate states of emptiness become indispensably necessary to the whole system of the venous circulation. Let us only examine this point with some attention more circumstantially.

WHEN the veins are all full, and the auricles, or chambers into which the veins empty themselves, are full also—Where is the collected stream in the veins to go next? There is no room for more in the auricle: What must be done?—Why, the auricle contracts and empties itself. What is the consequence? Why, a sudden vacuum, equal to what the auricle could contain—the turgid veins rush their contents into the auricle to fill up the vacuum again, and all behind
moving

moving in the venous direction advances so much forward, with such force, that the veins near the heart sustain a pulsation from the regurgitation of this impetuous stream, when the auricle shuts upon it to empty itself.—In short, the full auricle occupies a determinate quantity of room in the breast: When it is emptied, there is a non-resisting vacuum of so much space as was full before, and thither there is a mechanical nifus from the remotest filament of a vein over the whole body, which becomes conspicuous in the torrent that rushes every other moment from the mouth of the vena cava into this vacuum.

THUS not only the continuous veins, such as there may be, but every humid interstice and all the extravasated effluvia within the surface of the body, is sucked, attracted, or impelled, call it what you please, as it offers into the direction of the venous streams.—All
this

this is so mechanically necessary and so consequential, that I cannot help repeating my surprize that it has so long remained unascertained. But here I must not omit doing justice to the great Haller, who seems to have conceived some idea of the influence of vacuums on the circulation, when, some where in his physiology, he specifies a *vis derivationis quæ sanguinem a sede majis compressa ad sedem laxiorem et minus resistentem ducit*. Which power of derivation, he says, is not sufficiently known yet; and which I have here endeavoured to ascertain and explain.

SIXTH PROPOSITION.

Notwithstanding all the completeness of mechanical provisions that we find established for securing the circulation, yet they can be considered as no more than auxiliaries or accessories, seeing the motions of the animal system could not be kept in play one moment by them all, without the presidency and uninter-

uninterrupted influence of a power, which I will not say is unmechanical, but which we cannot reduce either to distinct mechanical rules or ideas. I mean that active principle existing every where in the system of animals, which I call *life*.—I do not mean that immaterial immortal part in us, whose concerns are more elevated and permanent than the regulation and support of a temporary material automaton.—I mean that supreme principle of natural life, which exists in every point of our frame, and disseminates its universal vitality in the irradiations of sensations, affections, volitions, &c. of every kind.

THE structure of our brain and its nerves, obliges us to consider this essential principle, at the same time that it is existent and in constant activity every where, as a real glandular secretion. Therefore, in its private office, the constant flux of this vital principle from the head to every point of our frame, must

[must be considered as essential to the perpetuating of the circulation in the head, as the secretions of other glands are to the maintenance of the circulation in them.

YET what is truly wonderful of this secretion, and may with propriety be proposed as a paradox, or phænomenon of the most difficult solution, is that it is a secretion without a waste, or without any consumption of the stock from which it is drawn *.—This renders the mode of the circulation in the brain dif-

* Thus it is that electrics *per se* are supposed to draw their electrical fire from non-electrical bodies, and to issue it always longitudinally into whatever direction the conductor is bent or twisted ; tho', if solicited by the approach of any non-electric, it is ready to burst out side-ways at any part of the length of the conductor. This obviates another difficulty in regard to the motion of the vital principle along the nerves. If it is so subtile as to penetrate their substance in all directions, how can it hold its course according to their lengths, and discharge its influence regularly where they terminate ?

ferent in its circumstances from all other parts of the body, the heart, the liver, or any where else ; because, as I apprehend, the blood which goes into the brain by the arteries is all returned undiminished back again by the veins : So that we cannot have at least that direct recourse to the influence of a vacuum there, that we have in solving the phenomena of the circulation in other glands. But at the same time that perpetual efflux constantly streaming off from the nerves, and animating every particle and fibre by its energy, must have a powerful influence on the circulation of the animal fluids, through the substance of the brain, both as a director and as a motive power—This I call the private office of this secretion.

THAT the nerves also shed their influence universally and intimately to every part and recess of our substance, is, I think, what no one doubts ; though few have reflected that it must, by a ne-

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cessary

cessary consequence, produce active vital effects, both upon the motions and dispositions of the fluids in every part—I shall attempt to ascertain this fact by an argument, which, if it should be thought new, will not, I hope, be rejected merely on that account, if, upon weighing, it proves conclusive.

NOTHING can be more certain and undoubted, than that the senses, passions, and volitions have not only a most powerful, but in many instances a most instantaneous and most sensible effect upon the motions of our fluids ; in some cases, throwing immediate colour and heat into particular parts of the body, and in others, throwing the whole frame into a colourless rigour, and spreading a languor over all the motions of the fluids:—in some instances, filling the whole machinery with an instantaneous lightness and vivacity in all its motion ; in others, as suddenly oppressing

pressing and in a great degree choaking all the vital powers.

Now, can it be supposed that this vital principle, distinct from all that we know of the mechanical composition of our frame, adjusted for maintaining the complicated motions of our fluids, could effect its motions so instantaneously, if it was not always present, and indispensably necessary to them at all times?—In short, it proves, that that very principle, which is constantly blazing in us in living sensations and passions, is as incessantly employed in promoting and regulating every living movement of our fluids in every part.—It could not act as it does in such instances as I have hinted at, unless it was constantly acting.

It has always appeared very strange to me, that many have been so curious in estimating all the mechanical circumstances they could conjecture to themselves, that might conspire in the circu-

lation, and in calculating their powers; as if any satisfactory sum total of the moving powers could be ascertained upon such principles.—In what we call mechanical, mechanics do all; but in a living machine, they do nothing.—It is life immediately and directly that does all; and mechanism is no more than a subordinate arrangement, seconding its operation, and a channel for life to move in.—What in physics are called the powers or laws of nature, are not more fundamentally essential to mechanics, than what I call *life* is to them in the animal system.—In the human frame, life occupies the known properties and tendencies of matter by means of mechanics; but no mechanics can be conceived by the human capacity which can perform what the living principle does.—Yet physiologists often reason and discuss their subject, as if life was the effect of mechanics, instead of considering them as only the track in which life moves, and the foot-stool of its powers.

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THE exertion and powers of the nervous system, acting uninterruptedly, and diffusing their virtue constantly in the same directions with these in which the animal fluids move, must efficaciously promote their progress.—Besides that animated vital character which the effluxes of that system superadd to the warmth and chymical commixture of the animal principles, in every solid and in every fluid particle of our frame, it instantly inverts, changes the arrangement, and disposes the habit of each moving particle, so as to become entirely metamorphosed, and invested with the particular character of that very part where it either flows, is secreted, or accretes.

IF we advert that life is but another name for self-activity, and consequently that the very essence of life lies in that activity, it is impossible but that the fluids in which that life resides, as much as in the solids, must enjoy activity as a

principle of their constitution, and not yield to motion by external mechanical impulses only, like inert passive masses. So active is this principle in us, that we cannot call our sensations or perceptions themselves more vivid than it is in every part.—Indeed our sensations themselves are not any thing else than perceptible copies of the instantaneous activity of this principle residing in the solids and fluids which compose every organ of sense, in receiving, and variously modulating itself to every impression that the course of nature without us can possibly make upon these organs.

BUT to drop the abstracted discussions that this branch of physiology suggests, and to be brief.—It is this principle of life, that gives that facility and momentum to the universal circulation of the animal fluids, which deserves the name of spontaneity ; without which, all the injectings and mechanical contrivances in nature could not open the recesses of
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the vascular system, and render them pervious to the most searching and penetrating fluids.—It is this inherent, or rather constantly influent principle, that renders all, both solids and fluids, so active, so vigorous, so consistent; and at the same time so placid, so obedient, and so permeable, infinitely beyond the reach of merely mechanical impressions.—In short, it is this, and not the diameters of vessels, the angles at which they divide, their elongations, flexures, or involutions, that renders all so lubricious, so various; and yet upon every change and secretion, so characteristic, and so uniform.—This work is not performed by the stubborn, robust agency of grinding, or dividing, by separations and percolations, strainings and squeezings of refractory combinations and commixtures of heterogeneous fluids: But every moving active particle of the fluids is presently, and without one protracting renifus, transmuted into the nature and habit which the organ it ar-

rives at, disposes it to assume.—This living temper and warmth oscillates in every solid fibre, and fans the fire of nature in every fluid particle that approaches them: While these again return the quickening vibration to every solid, and diffuse it reciprocally among themselves.

SEVENTH PROPOSITION.

FROM what I have, I hope, proved, it necessarily follows, that both the primary and the final intention of the pulsation of the heart in the animal œconomy, must tend to some purposes distinct from the necessary support of the progressive motion of the fluids. I shall bestow a few reflections on what some of these purposes may be.

FIRST, then, it must be attended to, that the alternate pulsations of the heart necessarily imply a correspondent alternation of the effluxes, or powers of the
nervous

nervous system, and of their origin the brain ; at least in so far as their powers immediately respect the action of the heart.

PHYSIOLOGISTS generally suppose that the chambers, namely, the auricles and ventricles of the heart, are in a paralytic state during the time of their diastoles, or during the time they are filling again with blood, after they have emptied themselves by their systoles or contractions. It is also now supposed by some ingenious physiologists, that the heart is constantly roused out of this paralytic state by the irritation of the blood that fills these cavities from time to time. But this theory wholly rests upon the supposition, that the relaxed state of these muscles is owing to some peculiarity in their structure, by which they cannot preserve their muscular contraction above an instant at a time, and that they cannot re-
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cover it but by the reiterated action of a stimulus upon them.

Now all this is so contrary to every thing that we know of the nature and tendency of muscular fibres in other cases, that the supposition ought not to be admitted upon less than a demonstration, that it cannot be explained upon other principles more agreeable to the animal œconomy. We have instances of the natural contractile power of muscular fibres being relaxed by irritation, as happens to both the sphincters of the principal excretories in the body when they are solicited to a discharge: But I do not remember one instance of muscular fibres whose natural contraction depends on irritation, not even the circular fibres of the iris.

No sound muscle can be in a relaxed paralytic state, except from a defect of the influence of the nerves
which

which communicate with it. Hence it follows, that the intermissions of muscular action in the heart, must proceed from an intermission in the action of the brain and nerves upon it. There must be established intermissions there of the effluxes from these organs of life upon the heart, which determine its alternate states of action and inaction.

THEREFORE before phyfiologists take upon them to determine the use of the contractions and relaxations of the heart, it becomes a necessary previous enquiry, to discover what may be the use of these intermissions in the vital organs where they originate; because possibly the importance of these alterations there, may be greater than in the heart, where they appear more sensibly, though only as an effect. I cannot propose here to enter more minutely into this disquisition: I shall therefore dismiss it with this reflection.

Seeing

Seeing reaction must always be equal to action; and as no effect can be greater than its cause, therefore the alternate efforts of the brain on the nerves that agitate the heart, must have as great an effect on the brain itself and its effluxes, as it has secondarily on the heart itself and the fluids whose course it regulates.

SECONDLY, there is good reason and ground to suppose, that the concussions of the heart have also a direct effect forward, upon the system of the solids in which the fluids agitated by the heart move. I do not mean merely that passive expansion and pulsation which it causes in the arteries, though I include it; but that every shock of the heart excites a reciprocal orgasmus, or active tension, through the whole series of the solids, which keeps them always prepared and enlivened for admitting and acting upon the fluids every where, in the manner

ner I have attempted above to express my conception of*. Whether the arterial and venous systems connected with the ventricles and auricles of the heart by tendinous-like beginnings, act as antagonists to the muscular contraction, I shall submit to the decision of further enquiry and observation.

THIRDLY, that the contractions of the heart also momentarily irritate and rouse that vital principle animating every fluid particle, I have no doubt of. But in order to comprehend fully the influence of the heart's contractions upon the fluids immediately passing

* There is some reason to question whether the mere mechanical force with which the blood is thrown into the arteries, is the direct and only cause of the force, wherewith the arteries vibrate. I have seen an aneurism in the arm that would have moved more pounds of weight than the artery either above it or below it, if I guessed aright, could move ounces. How that momentum was generated there, I leave to the reflexions of attentive physiologists.

through

through it, the circumstances and qualities of the blood brought by the veins to the heart must be considered.

WE are not, I have intimated already, to consider any part of the vascular system as a congeries of merely passive canals for the fluids. The importance of the veins, distinct from that of their being canals, has not been duly considered. Their office consists of two parts.

FIRST, that of thoroughly animalizing the recent chyle, which has undergone only an arterial course. — It is evident from the secretion of milk, that some of the finest filtrations of the arterial circulation remain still acescent: But the veins complete the change, and render all the fluids in them perfectly animal, and of consequence, they must exalt the animal nature of such of the fluids as pass through them a second or a third time.

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THE second branch of the office of the veins is, to elaborate the fluids into that form and composition which we know by the name of red blood. That this is the peculiar province of the veins is self-evident, I apprehend: For though there may be accidentally a continuation of some arteries containing red blood in ~~to~~ veins, yet it is certain there cannot be a continuation of such a quantity as to supply the twentieth part of the red blood found in the larger veins. It must therefore be concocted by the veins out of the finer fluids which they receive by absorption or otherwise.—In short, the ultimate office of the arteries is to resolve the blood into the various animal fluids and secretions; and the business of the veins is to combine and regenerate them again into red blood; for the arteries generate none, they only receive it already composed.

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THE blood, then, in the *vena cava ascendens* is not only perfectly animal itself, but it receives an accession of blood from the liver, which is still more highly animalized, having undergone a complete course of both arterial and venous circulation a second time; by which it becomes so highly exalted as not only to tend to dissolution itself, but to affect the rest of the blood with the same disposition, if it was to perform its course through the heart and arteries again without the supplement of fresh materials taken into the stock, which moderate its tendency, and furnish it with qualifying combinations, or mixtures.

ON the other hand, though the blood of the *vena cava descendens* must be as perfectly animal as that in the *ascendens*, yet its nature is no less diluted and let down, by the constant accession of fresh chyle poured into the left subclavian vein, than the blood
of

of the *cava ascendens* is exalted, by the accession of the hepatic blood.

THESE two then gush into the first chamber or right auricle of the heart; there they are confounded, and undergo first the conquaſſation of the auricle throwing it into the ventricle, and then the conquaſſation of the ventricle intimately mixing the two differently diſpoſed liquors, and throwing the compound out by the pulmonary artery, through the whole ſubſtance of the lungs, even into, I had almoſt ſaid, poſitive contact with the air we inſpire.

THE great and important intention of this courſe of the blood through the lungs is in order to ingroſs another ingredient, namely a portion of freſh common air, at each inſpiration, into the compoſition, in exchange for an equivalent portion of the moſt volatile effluvia of the blood, exhaled

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from the lungs at every expiration. With this addition, the blood is returned again from the lungs by the pulmonary vein, into the outer of the second pair of chambers of the heart, called the left auricle, where again it is agitated, or churned, and thrown into the left ventricle, where it sustains a fresh commixture by the contraction of the ventricle, which passes it at the same time into the great artery, called the aorta.—By these means the heterogeneous parts of the blood are so blended as to prevent the homogeneous parts from associating or combining, as they would be apt to do; and instead of that, they are disposed to that common elaboration and influence upon each others different qualities, which renders the whole mass fit for, and more susceptible of, the various changes and secretions it is intended to undergo in its course.

MANY physiologists have supposed the blood to undergo an actual fermentation, which implies a change of its nature, in the heart; but the stay of every portion of it there, is so momentary, and the mechanical agitation it is there put into, is so great, that that supposition is next to impossible; the animal changes not being so rapid as in the ebullitions of naked alkalis and acids.—There is no doubt however but that agitation is intended, not only to augment the heat of the blood, which disposes it to press outward, as all heat in bodies under its influence does, but so to mix the heterogeneous part, as to prevent any combination of similar parts, which might obstruct their so readily yielding to the animal mutations and exaltations they are destined for, under the influences of the powers of life.

THERE is another circumstance in the state of the blood passing the heart,

unattended to, which renders the shocks it receives there very necessary, and that is the great quantity of the fluids which are in the state of smoaking volatile effluvia, and the great tendency of all the parts of the blood, that are not combined in gluten or in red particles, to expand themselves into that state.

IF the blood was not thus mixed, and these effluvia kept equally dispersed among the other parts, portions of the effluvia would be apt to collect into an elastic mass by itself, and very suddenly coagulate or otherways stop the course of the rest of the blood. It is this accident, this elastic force of the effluvia, that sometimes bursts the heart contracting upon it, and becomes the occasion of the most sudden of all deaths, commonly, though falsely, imputed to an apoplexy.

THE large quantity of fluids disposed to expand into vapour is easily demonstrated

strated in the extremities of the body, by the great expansion of the veins beyond their natural size, whenever the parts are exposed to a greater than ordinary heat. On the contrary, in a state of greater than ordinary coldness, the veins collapse so much as to be scarcely discoverable.

ELASTIC vapour and air have been so confounded in all ages, on account of their common property of elasticity and expansion by heat, that it is with stricter propriety, or at least with a more direct reference to this circumstance, than we now apprehend, who have lost sight of that predominant quality in the blood, that the Ancients, especially regarding it, gave the name of arteries to that system of vessels into which the heart throws the blood; at the same time implying the air taken into the blood from the lungs, which it is part of the office of the arteries to subdue, so as to render it a constituent

part or agent in the process of animalization. The present philosophy would call this, rendering the air in the blood *fixed*: But I have not so clear conceptions of that matter so as to authorize me to adopt the phrase *.

T H E R E

* The fixed air which has become so fashionable a subject of investigation of late, said to be so noxious in the form of air, and so salutary united again with water or other fluids, is nothing else than a highly volatilized and active mineral acid, in the state of its first remove from, or last approach to the form of phlogiston. In all effervescence, during its action, some of the acid particles become so irritated, by the impetuous neutralization of others, that they are rendered highly volatile, collect in the fluid into little parcels of steam inclosed in small aqueous bubbles, which rise through the liquor, and break and discharge their effluvia on the surface of it. Of the same nature (only produced from vegetable substances) is that gas generated in and issuing from fermenting liquors. I remember, some years ago, to have seen a real kind of dulcified acid spirit distilled from a fermented, or rather fermenting, liquor; the singular taste of which I taught the distiller to correct, by mixing some absorbent with the spirit. I am persuaded that such an expedient for correcting such accidents, can be no secret to the distillers by trade. If Gentlemen of a philosophical turn would, in their researches,

THERE is one other consideration which suggests to us a very strong presumption, if not proof, of the large pro-

searches, converse more with tradesmen, they would often find solutions of very obscure problems in their practices. Sir John Pringle's fair and accurate historical detail, at the conferring the Royal Society's last premium on Dr. Priestly, of the slow progress made in the still imperfect discovery of the nature of Fixed Air, or mephitic air, is a striking proof, that there is no unlocking Nature's secrets without a key, nor searching into them without a light: without these we may torture Nature by our experiments long to little effect. Whereas the discovery of the proper key would save a great deal of that trouble, and it is often very easy to be found.

The fire-damp in coal mines is a highly elastic petroleous effluvia, bursting from deep seams of fatter and less consolidated veins of coal, by reason of the want of a sufficient resistance or circulation of the common air in such mines. The steith or mephitic is dephlogisticated sulphureous vapour, generated in a like manner in other mines.

The three mineral acids are the universal acid, diversly modified by subterraneous, marine, or aerial concoction. In the form of vapour they are all strongly elastic, and have been mistaken, under certain circumstances, for species of air. Each of these acids gives a specific modification to phlogiston; which they all either closely unite with, or comprehend in themselves, as somehow essential to their constitutions.

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portion

portion of this elastic vapour in the blood, and that is the proportions of the cavities of the heart to the proportion of blood that can be supposed to pass through it every pulsation.—I have not the least hesitation in declaring it absolutely impossible, that the auricles and ventricles of the heart receive and discharge either one-half or one-quarter of the quantity of blood it would require to fill them, at every pulsation.—The unequal sizes of the cavities of the heart, among themselves, is a certain proof of this.—Another is, the impossibility of even half a ton, far less two tons and an half, of blood passing through the lungs in the course of twenty-four hours.—One principal object, therefore, of the disproportion between the size of the cavities of the heart, and the quantity of blood they must receive between every pulsation, must be to give room for the expansion of the effluvia in the blood, that, by the contractions of the heart, it might be employed

employed to divide the blood more effectually, and be mixed with every portion of it more intimately.

I SHALL conclude this discourse, with a remark upon this propagation of animal life and motions by alternate action and remission of action, both in the brain and heart.—I will say nothing of the primary cause of it ; nor will I enquire how far it is, or whether it must not be, if abstractly examined, the necessary mode of all action. Only this we may venture to say, that it seems to be a favourite mode of supporting nature, both in the great world and in the little world, as the human frame is often called.—The final cause, or the end for which it is established in our frame, seems to be for the more effectual relief and support of nature, when it languishes, or is in hazard of being overpowered, or the motion of the fluids suspended and stopped by any sudden accident ; as in the cases of
great

great fear, horror, grief, or any extreme agony or struggle of contending passions.—When the native vigour of the solids, and nervous system, in such cases, becomes relaxed, and loses that reaction on the fluids, which is necessary to preserve their motion; then the heart throbs, palpitates, and redoubles its efforts to revive the languishing motions, warmth, and vigour of every part.

IN such cases, it is evident, the redoubled action of the heart is not from an encreased quantity of fluids brought to it, but the contrary; and the immediate encreased acceleration of its contractions is not so much to fill the vessels, which must be supposed fuller than before the constitution fell into these circumstances, but to react upon the languishing solids, and re-animate their prostrate vigour:—a certain proof this, that the actions of the heart have as immediate, nay a more immediate, connection

connection with the nervous system, the secretories of life, than with the immediate motion of the fluids as a mechanical cause thereof.

IN short, the respective powers and compounded influences of the brain and the heart upon the human frame, may, with great propriety, be compared to the agency of the sun and moon upon the great world.—The sun pervades all nature, and sheds his influences in its most intricate recesses, elaborating out of one whole, according to its various circumstances, and assortments, an infinite variety of properties and forms: while the moon, by a special regulation and flexion of his influences, disposes that great mass of fluids, which are the immediate organs of his energy, and the subject of all his operations and productions, into these tides and reciprocations of ebbing and flowing, which is, according to the constitution of things, so necessarily subservient

subservient to their being conveyed in a proper disposition, into all these elaboratories into which the sun, from whom nothing is hid, reaches.

JUST so in the microcosm, the brain, by the mediation and irradiation of its nerves, penetrates and animates every point of our frame, and particle of our composition, disposing every fluid particle to a spontaneous motion and accommodation of its nature to the character and structure of the parts to which it attinges; while the heart, by its reiterated impressions and shocks on both the solids and fluids of our system, gives an additional vigour to the animation and dispositions of the whole, and causes these perpetual collisions which irritate and invigorate the living flame that is glowing in every part.

I CANNOT, Gentlemen, take upon me to warrant the infallibility of every thought or suggestion I have risked in
this

this lecture; and the compass it restricts me to, has debarred me from further enlargement upon any of them. Several of these may be allowed to be problematical, without the main questions being affected thereby; but I persuade myself that I have proved both, my general proposition, and the seven inferior ones, under which, for the greater clearness and distinctness, I have distributed the evidence.—I have delivered my sentiments on this subject with the greater assurance, that they have the sanction of my friend Dr. Hall's approbation, whose judgment and abilities, independent of our friendship, I very highly esteem——



FOUR LETTERS

ON THE

NATURE and CONDITIONS

OF

LIGHT AND AIR.

ADDRESSED TO

Sir HILDERBRAND JACOB, Bart.



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FOUR LETTERS,

TO

Sir HILDEBRAND JACOB, Bart. &c.

L E T T E R I.

Of the Materiality of LIGHT.

S I R,

I HAVE taken occasion from my subjects in the preceding sheets to discourse of Light so particularly as related to the human frame, and as constituting both materially and virtually the most important part of our composition ; and I have pursued these views so far, that I find it necessary to say something of its absolute nature and conditions ; in order to remove, as well as I can, any obscurities or difficulties that may still seem to attend the subject.

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PERMIT me, therefore, to address to you some thoughts in proof of the *materiality*, the *plenitude* and of the *positive activity* of light absolutely or universally considered ; because they are principally extracted from a work, which tho' not finished, was long ago undertaken and begun under the favour of your auspices.

ARISTOTELIAN tho' it was, there was a great deal of shrewdness and sagacity in that old metaphysical definition of Light implied in the term *materia media*, intimating that it was a substance related in some manner both to *Spirit* and to *Body*. By an infinite series of sensible effects with which universal nature is momentarily every where teeming, whose causes elude all possible perception, Light, the fountain of them, justly deserves the name of *Anima*. But the great and reverend Antitype of this wonderful principle of nature, to prevent

vent all mistakes, has provided that some of its endless modifications should yield us satisfactory demonstration of its being Body and not Spirit, and of its operations being mechanical and not rational.

MECHANISM bearing immutably the same relation to material principles as reason does to spiritual ones, mechanism becomes a certain medium for ascertaining the materiality of principles that act or are acted upon by its laws.

THAT Light and Fire are substantially or materially the same, is evident from their commutability or their reciprocal generation of each other. For as fire necessarily generates Light, and discovers itself to the sense of seeing as infallibly as to the feeling ; so light, converged into a focus, constitutes pure elementary fire, without the interposition of any medium or other subject necessary for its support. Again, Light and

Heat are propagated by the same laws. They act in straight lines—They diffuse themselves from a centre outward—Their powers decay according to their distances from the centers from which they are irradiated—They are subject to the same laws of reflection.—

AGAIN, the senses which we are provided with to acquaint us with the powers of light or fire, are formed upon the plan of the most exact and refined mechanism, and therefore are prepared only for the impressions of what is strictly and properly material.

SIR, these few circumstances, without the necessity of any commentary or enlargement, are fully sufficient to certify decisively to our reason, that light and fire are substantially the same, and that that substance is a material or corporeal one.

I am, SIR, &c.

L E T-

L E T T E R II.

Of the Density of LIGHT.

S I R,

IT is a very natural question, and of very great physical importance to be decided; in what proportion, as to quantity, does this matter exist in the universe? It must be owned, that Sir Isaac Newton has out-done himself in his Theory of Light and Colours, as much as he has excelled others in his other works. Nothing can be finer, and a greater display of his extensive genius, than his Optics, notwithstanding his Theories being clogged with unfurmountable difficulties; some of which I beg leave just to mention to you.

FIRST, The immense velocity he assigns to Light, not only exceeds all credibility, but it is absolutely impossible:

Neither the tenuity of its parts, nor the rarity of its rays can absolve it from tearing to pieces and dissipating in a moment all terrestrial substances: Whatever power it is that gives the densest bodies their consistence and fixation, yet we know that it is a limited one, and one whose limits bears not the proportion of one thousandth part of the momentum with which the rays of Light issuing directly from the Sun, upon Sir Isaac Newton's computation of their velocity, strikes every point of their surface, and penetrates every pore in their substance.

SECONDLY, This velocity, according to Sir Isaac's scheme of it, is reduceable to no possible mechanical regulation. It moves just as fast by reflexion from the coldest substance, as from the boiling furnace of the solar fire. Who can believe that a glow-worm has a power of giving Light the same unconceiveably intense quantity of motion, that a centre
of

of fire animating the whole universe has?

THIRDLY, Who can conceive it possible that a fluid, such as Light, which does not exhibit one symptom of the very weakest degree of any cohesion among its parts, should keep with such unvariable regularity, moving rank and file, in diverging lines? Can we suppose that the particles of boiling water, vomited from the mouth of a volcano, can preserve any relative order in their eruption?

FOURTHLY, This impossibility presses still harder upon us, when we extend the unconceivable regularity of this progression so far, as to allow it supposable, that the seven threads of which every ray of Light is composed, shall immutably retain their lineal order and relation without any possible confusion, or jumbling together beyond all possibility of regular analysis. We may as

well suppose it possible that the spirit, the acid, the sugar, and the water, in boiling punch, can be so distributed in boiling thro' a funnel as to preserve each their relative order of affinity in the midst of their tumultuous confusion. These things cannot be.

FIFTHLY, How can it be conceived that the principle of attraction which, at any small assignable distance, suppose the three hundredth part of an inch, is infinitely weaker between bodies than the momentum of Light moving at the rate of fifteen hundred thousand miles in a minute, or fifteen thousand miles in a second of time, should yet at such a distance sensibly bend and incline the atoms of Light in such a rapid motion, off the straight line? mathematics themselves reclaim against the possibility of such a proposition.

LASTLY,

LASTLY, I have always deemed it the most inconceivable and incredible of all the mysteries that ever philosophy propounded to human credit, that *nothing*, or the supposed empty spaces in coherent bodies, can have a power of reflecting rays of Light impinging with such infinite momentum against it.

I DO not, Sir, I cannot doubt of the phænomena that have suggested these inferences ; but they being physically impossible, there remains no other way of explaining them than by concluding, that Light exists in such a condition as to quantity, as can be supposed to produce these phænomena without the necessity of having recourse to impossibilities.

A PLENUM of Light will account for the phænomena ; and no other supposition can do it. Admit the supposition of a plenum to be clogged with difficulties to our conceptions ;
still

still it is embarrassed with none so repugnant to the nature of things, as the suppositions I have mentioned. A plenum will account for an instantaneous impression of Light upon our senses by the remotest objects; and it is much more natural to suppose, that certain circumstances in some immensely remote cases, may make us apprehend that some small time is spent in its transmissions, when in a plenum it should be instantaneous, than to suppose that any body can move thousands of miles in the twinkling of an eye.

A PLENUM is no way inconsistent with Lights acting in straight lines on our sense, or with its being put in action in either diverging or converging lines: But it is impossible that out of a plenum, a fluid with no lineal adhesion can fly away to all distances inropy tenacious-like threads, incapable of being confounded or deranged.

ranged. In short, a plenum tends to contravert none of the phœnomena of Light and Colours; tho' I confess it will alter the interpretation of some of them. If there is apprehended any inconvenience in that, it is only such an one as will initiate us into more knowledge upon that subject.

I KNOW the only plausible objection against a plenum that ever could be urged, is the difficulty of conceiving the possibility of motion in one. Indeed, if *Attraction* is, what some philosophers have now pronounced it to be, an essential adjunct of materiality; there can be no distinction between an universal plenum and an universal solid. But as I take solidity to be like all the other various modifications of bodies, a physical result of the composition of nature; Solidity and a Plenum have no connection with one another in my ideas. But let us take nature as it is, and according to it, examine

mine the weight of this objection to a plenum.

FORMERLY philosophy accounted water itself so completely a plenum as to pronounce it incompressible; yet still in that state it remained a fluid susceptible of an internal motion of all its parts. Now, indeed, they say it is capable of some degree of compression, and I fancy, if they will put it into circumstances proper for subjecting it to the experiment, they will find it elastic also. But whether these things are so or not, they do not affect my argument; for the internal motion of a plenum of water can be ascertained by bodies moving in it, that have no power to make room for themselves by compressing it. Water then is so far a plenum, that it is scarcely compressible. This water, as hot as boiling, is such a plenum in a constant internal motion of all its constituent parts. The Light passes
as

as regularly and transparently thro' a glafs of boiling hot water, as if it was a piece of solid chryftal.

THE Light passing thro' a piece of chryftal may be explained by the pores of the chryftal lying in lines parallel to the lines of Light; but this will not folve the phœnomenon of the Lights passing in ftraight lines thro' a boiling hot fluid, whose pores cannot continue one moment in the fame parallel pofition to one another. If then, this marvellous fluid can preserve its action as Light uninterruptedly, thro' a plenum whose internal parts are in perpetual motion; is there any wonder, that in the pure medium of its own plenum, it fhould make its impreffion on our fenfes in the direction of rays or lines, without the neceffity of fupposing its operations must be diftracted, becaufe they are performed in a plenum; or without the neceffity of fupposing that every atom
of

of Light that delineates on my eye the sense of an object, must have been issued or reverberated from that object, in the same manner that a ball tossed against a wall, recoils back into the hand again?

I BEG leave, Sir, to add, that there is no occasion for any other argument to decide the existence of a plenum of Light or Fire, but those mentioned in my former letter in proof of its materiality. For mechanism as necessarily implies plenitude of matter, as it implies materiality itself. It cannot subsist but where the parts of the machine are in constant influencing contact with one another every where. This is strictly all the definition that can be given of a plenum.

It is very remarkable, Sir, that though the doctrine of a plenum was very general, nay, almost universal among the Ancients, it was held amongst

mongst them as a matter of fact they were convinced of; rather than as an Hypothesis they had much use for in philosophising. Had they connected the idea of mechanism with their acknowledgment of a plenum, they would have perceived presently, that they had no occasion for assuming the Hypotheses of occult qualities, or of motions being essential to matter; which was the opinion of the Epicureans, and is said also to have been the opinion of Democritus, Leucippus and I believe of the Phœnecian Moschus also—in short of all the Atomists.

IT is generally believed, but without sufficient foundation, that the Atomists maintained the doctrine of a vacuum in the same sense in which it was revived among the Moderns by Gassendus, and now forms a fundamental doctrine in our system of physics. But it is evident from *Lucretius's* manner of reasoning in defence of a vacuum,

vacuum, that the Epicureans meant no more by it, than such a vacuum as they conceived to subsist within the substance of water, or of any fluid; whose parts are, nevertheless, all apparently in contact with one another, which is all the plenum that is required in a mechanical system.

HAD the Ancients only conceived that a plenum was susceptible of structure and mechanical arrangement, their system of physics would have been complete, which, by their not comprehending that important circumstance, was very imperfect.

I am S I R, &c.

LET-

L E T T E R III.

Of the ACTIVITY of LIGHT.

S I R,

WHEN a plenitude of light is confessed and admitted, it remains a point of no small importance in physics to be determined, in what condition, in respect of rest or motion, does this fluid always exist? All fluids we are acquainted with, when undisturbed, have the same appearance of both superficial and internal quiescence that a solid has. We know that all fluids are endowed with a mobility of their parts, but they are not generally supposed to be in actual motion, save when they are disturbed or agitated.

OF all fluids known in the universe,
the mobility of light is the greatest. It
T may,

may, with the strictest propriety, be said to be possessed of mobility in the abstract. There is not the smallest speck of colour, nor a visible mote in the beams of the sun, that it does not obediently receive perpetual impressions from in all lineal directions, by night as well as by day. The sun, as a fountain of motion, also, is perpetually agitating it either radially, or obliquely by the lateral shocks and friction of these radii upon these parts of the fluid that lie out of the line of, or are shadowed from the sun's irradiation. In like manner, the remotest fixed star is not without its influence upon the light's mobility. Therefore, considering this inconceivable mobility in the light, the infinitely various impressions it is constantly receiving, it cannot otherwise be, than that it should constantly be in a state of internal motion of its parts.

BUT all this is vastly insufficient to convey to us any adequate idea of the
constant,

constant, positive, intense energy of the activity of the light ; which we may more easily form some conception of, by examining into the mode of its possessing the interior parts of all other the most rigid and solid bodies. This I shall illustrate in the cases of sonorous bodies, and from the phenomenon of hammering cold iron red hot.

IF it was not irrational, when we know of one sensible universal fountain of motion which sheds its energy thro' all nature, to suppose that motion can be a property of matter inseparable from its existence, one would be tempted to think with Epicurus that motion really was of the essence, if not of all matter, at least of the matter of light. Even in the most secret recesses of the most solid and passive substances, light is so far from existing in an indolent quiescent state, that it is impossible to form an adequate idea of its incessant active energy under these circumstances.

It is constantly acting with such power within the most dense terrestrial substances, that when all the phœnomena belonging to them are duly weighed, it may be a question whether any two terrestrial atoms of matter are in positive contact with one another. This state of bodies is little thought of in our researches into their properties, either common or special.

If light resided within bodies in an indolent passive state, it could exert no reluctance to any external mechanical force disturbing its passive occupation of its spaces within bodies. But in fact, its natural state there is never disturbed without an irritation being excited in that fluid, greater than that with which it was expelled, to recover and repossess its organical and interstitial inherency : it returns with a force not barely sufficient to recover the dimensions it occupied within bodies, but with a violence able to expand them as much beyond

yond their natural size as any external blow or concussion tended to compress them within it : so that a vibratory col-
luctation between that action which preserves bodies in their natural crasis, and the rapid returns of light to its natural state is raised, which continues for some time, and dies away imperceptibly.

THIS intense agitation, excited by the collision of bodies, is not confined to their points of contact, but pervades their whole substance, and oscillates in every part.—We have demonstration of this both to the eye and to the ear, when a musical chord is struck. In all elastic bodies that are sonorous, we have specimens of the same.—When a bell is struck, the sound continues labouring in the ear for a considerable space of time afterwards ; nor is the tumult composed, when our sense of it fails ; it passes through a gradual decay below the standard of sense.

IRON is a metal that discovers no great degree of this sonorous quality, yet when a poker is held suspended by the head between one's teeth, and is struck in that state of suspension, the holder of it has a very striking feeling of the vibratory motion its whole substance conceives from the stroke, by the teeths transmissiion of their feeling to the ears.

PHYSICIANS talk of the irritability of our nervous system as a very mysterious and wonderful phenomenon, but we have still more striking examples of this irritability in the most rigid dead substances. Substances, such as bell-metal, glass, &c. which, tho' they are so rigid that almost no instrument will make an impression on them, are yet capable of being agitated through every atom of their substance ; nay, in some cases, to be burst in pieces by the very impression of certain sounds upon them. A wine glass will burst in pieces by the action ex-

cited

only one }

cited through its substance, by certain tones of the voice ; and when the vibrations of sound are excited in the strongest bells, a very slight resistance to that internal agitation is ready to crack them ;—a pack-thread fastened tightly about them, I have been told is sufficient to do it.

THIS excessive mobility of parts throughout the whole substance of the most rigid bodies, seems to imply so great a turgency of their substance with some very active fluid, that a small increase of it would be ready to burst them in shivers, as actually happens to these glass drops, let fall into water when they are red hot, whenever the small thread formed at one end of them by the tenacity of the semi-liquid glass, is snapped.

IT is impossible to conceive how such a tremulous motion should be produced through the whole continuity of such

hard bodies, unless they contained in themselves some inconceivably active element exerting a constant nîsus to force their parts at as great a distance from each other as possible, and that was barely counteracted by the power that maintained their cohesion.

THE symptoms of this restless activity within solid bodies are not confined to such as are commonly called elastic. Iron is more dense than any body of greater elasticity than itself; at the same time, it is considerably plastic or susceptible of extension by hammering, &c. yet it yields still more striking proofs of this latent active principle, than any most elastic body can do; and such at the same time as discloses to our sensible conviction, precisely what that principle or restless element is, that exerts its energy so powerfully within all terrestrial bodies.

WE are apt to conclude that when any plastic body is so pressed by any external application, as to make it change its figure and the internal relative arrangement of its parts, that all is immediately at rest within it, and that the whole immediately acquiesces in the form it receives. But this is by no means the case. That power in bodies which sustains and preserves their form, is not a passive one. It is a positive re-action to the parts of bodies approaching nearer each other than they naturally do; or, in other words, which resists their approaching so near one another as they would do, if that reacting element was not interposed among their parts.

THE law of re-actions being equal to action, resides ultimately in the constitution of this powerful fluid medium. Whenever the spaces it occupies within the surface of bodies are pressed nearer one another by any sudden shock or collision,

collifion, and confequently this medium is for an infant wrung out, the next infant it returns with violence not fufficient to regain its natural room in the body, but with violence equal to that with which it was ejected ; and therefore in returning, it dilates its fpaces as much beyond their fizes, as they were compressed below their natural ftandards by the collifion : by which means a temporary ofcillation is excited between the efforts of that power which circumfcribes bodies, and binds them to their natural fizes, and the internal medium which was irritated by the ftroke to re-aét with a force equal to it.

If thefe ftrokes which difpoffefs this fluid of the fpaces it naturally obtains within bodies, are quickly fucceffively renewed, before the colluctations raifed by the former ones have fubfided ; the internal agitation can foon thereby be raifed to fuch a height as to break forth, and manifelt itfelf in the form of actual fire.

fire. The most obvious and sensible demonstration we have of this, is in the beating of a piece of cold iron red hot.

A PIECE of iron briskly hammered on the anvil, acquires an encreased degree of heat by every stroke given it, until it becomes actually ignited. Real fire in all its characters is disclosed by the repeated action of two cold bodies upon one another. The fact has been long well known to the ignorant as well as to the learned ; but the inferences it necessarily yields, seem to have been as little adverted to by the one as by the other. But knowledge will make quicker advances by reasoning upon known facts, than by discovering new ones, which though they enlarge and add to the subjects we ought to reason upon, are apt by their novelty to surprise us into hasty undigested theories and hypotheses.

Now,

Now, as heat is known to expand and enlarge the volume of all bodies, and as every degree of external violence upon bodies must have a determinate degree of tendency, however imperceptible, towards the same effect; it follows, that every degree of external force sufficient to disturb their natural crasis, must have a consequential momentary effect in encreasing their sizes. —As an inference, the fact appears certain and intelligible; but as an unexplained proposition, it would appear a paradox, more likely to be rejected as false, than to be admitted as a truth capable of interpretation.

It may not be impossible, from the above mentioned known experiment of the beating cold iron hot, to fall upon a medium for calculating what quantity of mechanical force is equivalent to that quantity of motion in light which produces any given degree of heat. The phœnomena of elastic and sonorous
bodies

bodies likewise serve to illustrate the precise nature of irritability in animal bodies, and may likewise be of some use in unfolding what must be the particular constitution of the parts in which it resides, and to what the different degrees of it in different animal parts and in different constitutions is owing.

As this universal fluid is known only by its sensible effects, therefore, from these, we are obliged to denominate it, **LIGHT** or **FIRE**: and I have shown in some degree, what testimony they bear to the amazing intenseness of its perpetual agility. There is another attribute which it is no less distinguished by, though less attended to, namely **POWER**. But to open this subject fully, would be to discuss the whole subject of natural science. The strokes of the power of this element is well known in the effects of lightening, but these I do not so immediately refer to. It is the basis of the power of all other bodies : upon
it

it their stability depends. It daily forms what no other power can change ; and what no other power can change, it transforms in a moment.

I am, SIR, &c.

L E T T E R IV.

Of A I R.

S I R,

N O length of time can entitle an error, even in the terms of physics, to prescription. I do not know how old the impropriety is, but it certainly is a very gross one, to call air a *fluid*. With the same propriety, smoke issuing out of a chimney may be called a fluid.

EXPERIMENT has never yet been able, nor, I believe, never will be able
to

to condense air into a fluid, or to bring the constituent particles thereof into contact with each other.

EVEN the particles of a proper fluid, when in a state of vapour, possess one property essentially different from fluidity. They are not only not in contact with one another, but they have no nifus or tendency to come into it, or draw nearer each other, when they have free room to expand: then, they invariably exert a nifus, or a nifus is exerted upon them to separate more and more. In this, proper air agrees with vapour or elastic effluvia, and therefore it has no title to the appellation of a fluid.

WHILST philosophy has confounded air with fluids on the one hand, it has been, and is at present, very busy in confounding it with vapour on the other hand. Hence, physics are just now over-run with a multiplicity of *airs*; because there are few consistent
bodies

bodies but what, by a proper encher-cifis, may be made to yield a volatile elastic vapour.

It was always well known to a class of philosophers now out of date, that the parts of all consistent bodies were bound together by a secret acid principle ; an embodied ether, which acts as the great principle of adhesive attraction every where. When this is unbound, it manifests itself in the form of an elastic acid vapour, coercible in different degrees, according to the nature of the bodies it is expelled from.

THIS acid principle is so universal, that it is known to lodge in all alkalis themselves, excepting calcified ones ; and calcification is no more than expelling this acid from calcareous alkaline substances. To the particular modification of this acid in the sulphur of iron, is owing the principle of magnetism itself.

THE

THE nature of acidity has not been sufficiently enquired into. Physicians say acids are cold, and prescribe them with that intention. Chymists say they are hot, and burn every thing. Concentrated, they have a corrosive burning attraction; diluted, they cool by attraction, damping and fixing to themselves these particles of substances which have generated most heat, or have the strongest tendency to do so.—What is the reason that both lightning and electricity often excite a sulphureous smell?

It was an old opinion in physics, that common air is impregnated either with the nitrous acid, or with nitre itself: hence the phænomenon of freezing was explained by that hypothesis. That there is an affinity between the nitrous acid and common air is highly presumable: but it is much more likely that that acid is the universal acid, associated with some particles of the common

U

air,

air, than that common air is that acid.

THE common air may not improperly be called the phlogiston, without which no other combustible substance containing the terrestrial phlogiston, can deflagrate or be consumed.

THERE is one property or character of common air, which essentially distinguishes it from all other known substances; and which naturalists should have satisfied themselves, whether any of their elastic effluvia possessed, before they had confounded them even in name with the common air.—Common air as invariably rushes into a fire, or presses toward any such centre of motion, as all other substances recede, or are impelled by the receding energy of light, from such a centre.

THERE is a very obvious phœnomenon, which yet I do not remember to have

have been noticed by any naturalist, that seems to instruct that we are constantly receiving recruits of common air, if not from water, at least from the earth, through the water that covers it. Ice is well known to be full of air bubbles; and that these are not generated in or extricated from the water immediately freezing, is evident from this observation. By examining a pond or any piece of standing water, whose bottom is covered with stones of different sizes, after it is frozen over, one will always observe the air bubbles in the ice over the stones, larger both in size and in quantity; not indeed perpendicularly over the stones, but collected in irregular circumscribing lines, defining both the form and the size of each stone; which seems to imply that the air ascending out of the earth, where the stones lie, through the water, is turned from its perpendicular ascent by the stones, and then rises perpendicularly round their edges towards the surface,

face, till it is arrested by the ice on the surface.

IF we could pay a quick and sagacious attention to the processes that Nature is constantly carrying on, on every hand of us, we might be stocked with an endless fund of instructing observations and phenomena, without the expence of an apparatus for them.

I HOPE, Sir, you will excuse me for the liberty I have taken to trouble you with these thoughts on Light and Air, that are thrown but unartfully together in the foregoing letters.

I am, with respect

and esteem, Sir, &c.

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